

Low tech SMEs and international R&D cooperative projects in the EU: a pathway for the ‘de- territorialisation of closeness’?

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Master Thesis Dissertation

March 2006

Take nothing on its looks; take everything on evidence. There's no better rule.

In “Great Expectations”

Charles Dickens

To my father, always in my memory

Acknowledgments

In first place, I want to thank my supervisor, Aurora Teixeira, for her patience, comprehension, availability and friendship. Her scientific knowledge, rigor, exigency and persistence inspired me to overcome my limitations. Her incomparable work capacity is an example that I will try to follow.

To Ana Paula Delgado and Ana Oliveira Brochado, co-authors in two different papers related to this work, from whom I have greatly benefited in terms of suggestions and comments.

I thank to Eng. Cristina Guedes (GRICES) and Dr. Margarida Garrido (Direcção Geral da Empresa, Portugal) the useful information they provide about the CRAFT Program.

To João José Pinto Ferreira, the MIETE director, for his friendship and availability to solve all my problems related with my Master work, even when they were small.

I thank, also, my MIETE's teachers, Alexandra Xavier and Milton Sousa, for the friendship, the knowledge they have transmitted and the understanding demonstrated with my tasks delays.

Special recognition is dedicated to my friend and colleague, Catarina Aroso Monteiro, with whom I shared ideas and projects during our Master works.

For finishing some special and meaningful words to my family,

to Maria Fernanda, my sister and godmother, for unconditional support and for always believing in my capabilities;

to Maria João, my wife, for the incentive to get into this Master venture, the total commitment with my aims and relevant advices. Her insuperable support and conviction in my capacity made me stronger. This thesis is also dedicated to her.

Resumo

Apesar da considerável quantidade de evidência empírica sobre colaboração inter-empresas em indústrias baseadas em tecnologia, existem poucos estudos relacionados com a cooperação em investigação e desenvolvimento (I&D) de empresas de baixa capacidade tecnológica, especialmente as pequenas e médias (PMEs). Para ligar as PMEs e a I&D o mais recente ‘Framework Program’ (FP6) da União Europeia define um instrumento autónomo para aumentar a capacidade tecnológica das PMEs, o ‘Cooperative Research Action for Technology’ (CRAFT). A visibilidade e promoção deste instrumento reflectem a cada vez maior importância atribuída à necessidade de aumentar as capacidades de inovação das PMEs de baixa capacidade tecnológica. Nesta tese pretendemos acrescentar adicional e detalhada evidência empírica a esta área escassamente estudada.

Enfrentando a intensificada tendência para com a cooperação formal, nomeadamente através da I&D inter-empresas, vários autores têm realçado os benefícios da proximidade geográfica. Efectivamente, um número alargado de estudos na economia geográfica tem realçado o papel da proximidade espacial e a sua relação com a localização da criação de conhecimento em vários tipos de conexões. Menos atenção tem sido dedicada para entender as determinantes da proximidade ‘cultural’ e geográfica nos projectos internacionais de cooperação na I&D. Além disso, pouco é conhecido sobre a significância das diferenças inter-regionais na propensão das empresas para cooperar e da relação entre o comportamento cooperativo e a qualidade dos sistemas regionais de inovação (SRI).

A presente tese procura endereçar essas lacunas providenciando alguns resultados sobre redes internacionais formais de I&D, que incluem PMEs e institutos de I&D – tenta avaliar os efeitos da complexidade tecnológica, tamanho dos projectos e a força dos SRI na proximidade cultural e geográfica da rede de participantes. Usando uma base de dados com 118 ‘histórias de sucesso’ de projectos CRAFT completados, concluímos que projectos tecnologicamente mais complexos são mais propensos a envolver parceiros mais distantes ‘cultural’ e geograficamente. Adicionalmente, as variáveis relacionadas com os SRI determinam proximidade ‘cultural’ mas não proximidade geográfica entre os participantes da rede. À primeira vista, surpreendentemente, os projectos de cooperação internacional envolvendo os primeiros promotores de regiões altamente inovadoras (alta propensão para patentear e altos níveis de capital humano) são culturalmente mais distantes.

Concluimos ainda, através de um estudo de caso, que o critério de ‘sucesso’ publicitado dos CRAFTs é, no melhor dos casos, não consensual e por isso susceptível de controversa; uma via interessante e estimulante de investigação futura.

Abstract

Although a considerable amount of empirical evidence on inter-firm collaborations within technology-based industries exists only a few works concern R&D cooperation by low-tech firms, especially SMEs. To bridge SMEs and R&D the most recent European Union's Framework Program (FP6) defines an autonomous instrument to enhance SMEs' technological capacity, the Cooperative Research Action for Technology (CRAFT). The visibility and promotion of this instrument reflects the increasing importance attributed to the need for improving low tech SMEs' innovation capabilities. In the present thesis we aim at adding further and detailed empirical evidence on this scarcely tackled area.

Facing the intensifying trend toward formalized cooperation, namely through inter-firm R&D, several authors have made the case for the benefits of geographical proximity. Indeed, a large number of studies in economic geography have emphasized the spatial proximity of economic activity and its relation to the spatiality of knowledge creation in various types of connections. Far less attention has been paid to the understanding of the determinants of 'cultural' and geographical proximity in international R&D cooperation projects. Moreover, little is known about the significance of interregional differences in the propensity of enterprises to cooperate, and the relationship between cooperation behavior and the quality of the regional systems of innovation (RSI).

The present thesis seeks to address these gaps by providing some results on formal international R&D networks comprising SMEs and R&D institutes - it tries to assess the effect of technological complexity, project size, and the strength of the RSI on the cultural and geographic proximity of network participants.

Using a database of 118 'success stories' of completed CRAFT projects, we conclude that technologically more complex projects are more likely to involve 'culturally' and geographically distant partners. Additionally, RSI-related variables determine 'cultural' proximity but not geographical proximity among network participants. At first sight surprisingly international cooperation projects involving the first promoters of innovation-led regions (high patent propensity and high human capital levels) are culturally more distant. We further concluded, through case study analysis, that the publicized 'success' criterion of CRAFTs is, at the best, non consensual and thus likely to be controversial; an interesting and stimulating pathway for further research.

Keywords: Regional Innovation System; cooperation; innovation; SMEs; CRAFTs

Index of Contents

ACKNOWLEDGMENTS	I
RESUMO	II
ABSTRACT.....	III
INDEX OF CONTENTS	IV
LIST OF TABLES	VII
LIST OF FIGURES	IX
INTRODUCTION	1
PART I – LITERATURE REVIEW ON INTER FIRM COOPERATION AND THE ROLE OF PROXIMITY	5
CHAPTER 1. R&D, KNOWLEDGE CREATION AND APPROPRIATION. SYSTEMATIZING THE RELEVANCE OF R&D COOPERATION FOR SMES	6
1.1. CONCEPTS OF R&D.....	6
1.2. KNOWLEDGE, HUMAN RESOURCES AND R&D.....	7
1.3. OVERCOMING COSTS OF R&D KNOWLEDGE CREATION AND TAKING ADVANTAGE FROM IT THROUGH COOPERATION	9
1.4. THE GROWING TREND TOWARDS R&D COOPERATION. THE PARTICULAR CASE OF SMES R&D COOPERATION	10
CHAPTER 2. CRITICAL DISCUSSION AROUND THE CONCEPTUALIZATION OF GEOGRAPHICAL, CULTURAL AND TECHNOLOGICAL PROXIMITY BETWEEN FIRMS	16
2.1. DEFINING GEOGRAPHICAL, CULTURAL AND TECHNOLOGICAL PROXIMITY	16
2.2. THE SPECIFICITY AND RELEVANCE OF GEOGRAPHICAL PROXIMITY FOR INNOVATION	17
2.3. BEYOND GEOGRAPHY: THE PLEAD FOR CULTURAL PROXIMITY IN COOPERATIVE INTER FIRM RELATIONS	19
2.4. THE ODD ROLE OF TECHNOLOGICAL PROXIMITY IN INNOVATION COOPERATIVE RELATIONS.....	21
CHAPTER 3. R&D INTER FIRMS COOPERATION. UNCOVERING SOME GAPS.....	23
3.1. THE NEGLECTING OF LOW TECH FIRMS IN R&D COOPERATION	23
3.2. NEED FOR INCORPORATING GEOGRAPHICAL, CULTURAL AND TECHNOLOGICAL PROXIMITY DIMENSIONS INTO THE ANALYSIS OF R&D COOPERATION	24
3.3. ACCOUNTING FOR THE QUALITY OF REGIONAL SYSTEMS OF INNOVATION (RSI) IN COOPERATION RELATIONS.....	25
PART II – AN OVERVIEW OF EXISTING EUROPEAN POLICIES TO PROMOTE SMES R&D CAPABILITIES. THE SPECIFIC CASE OF CRAFTS	27
CHAPTER 4. CRITICAL ANALYSIS OF DIFFERENT INSTRUMENTS AVAILABLE AND THEIR GOALS	28

4.1. DESCRIBING THE EUROPEAN UNION INSTRUMENTS TO IMPROVE FIRMS R&D PERFORMANCE	28
4.2. THE CHARACTERISTICS OF CRAFT PROGRAM AND ITS OPERATIONALISATION.....	32
4.3. THE CRAFT PROGRAM COOPERATION SCHEMA SPECIFICITY: A PATHWAY FOR COOPETITION.....	33
CHAPTER 5. DETAILED ACCOUNT OF THE CRAFT PROGRAM, WITH AN EMPHASIS ON ‘WELL SUCCEEDED’ PROJECTS	36
5.1. GATHERING DATA ON ‘WELL-SUCCEEDED’ CRAFTs	36
5.2. SOME DESCRIPTIVE RESULTS OF THE DATA	37
5.2.1. <i>General description</i>	37
5.2.2. <i>Classification of ‘well-succeeded’ CRAFTs by activity area</i>	38
5.2.3. <i>Classification of ‘well-succeeded’ CRAFTs using Pavitt taxonomy</i>	39
5.2.4. <i>Classification of ‘well-succeeded’ CRAFTs using OECD taxonomy (high-tech; medium tech; low tech)</i>	41
5.2.5. <i>Country and regional distribution of the projects</i>	43
PART III – AN EMPIRICAL ANALYSIS ON THE DETERMINANTS OF GEOGRAPHICAL AND CULTURAL PROXIMITY IN INTERNATIONAL R&D COOPERATIVE PROJECTS. ASSESSING THE RELEVANCE OF REGIONAL SYSTEMS OF INNOVATION. 48	
CHAPTER 6. ESTIMATING THE DETERMINANTS OF GEOGRAPHICAL AND CULTURAL PROXIMITY. THE RELEVANCE OF THE QUALITY OF REGIONAL SYSTEMS OF INNOVATION.....	49
6.1. INITIAL CONSIDERATIONS.....	49
6.2. RSI CONCEPTUALIZATION AND THE RELEVANCE OF ITS QUALITY TO ‘BOOST’ INTERNATIONAL COOPERATION.....	49
6.3. CONSTRUCTION OF RSI-STRENGTH PROXY	51
6.4. PROXY CONSTRUCTION FOR ‘CULTURAL’ PROXIMITY AND GEOGRAPHICAL DISTANCE USING CRAFTs	52
6.5. MODEL SPECIFICATION AND VARIABLE DESCRIPTION.....	52
6.6. ESTIMATION RESULTS	56
CHAPTER 7. A PRELIMINARY AND QUALITATIVE ASSESSMENT ON THE PERCEPTION OF SMES’ REGARDING THE ‘SUCCESS’ OF CRAFTs. A PATHWAY FOR FUTURE RESEARCH.....	62
7.1. WHAT IS THE EU CRITERION FOR ‘WELL-SUCCEEDED’ CRAFTs?.....	62
7.2. SELECTING A PARTICULAR CRAFT PROJECT AMONG ‘WELL-SUCCEEDED’ CRAFTs	63
7.2.1. <i>Methodology and general description of the selected CRAFT</i>	63
7.2.2. <i>The ‘official’ outcome of the selected CRAFT</i>	65
7.3. THE QUESTIONNAIRE AND ITS IMPLEMENTATION	65
7.4. COOPERATION RELATIONSHIP BETWEEN PARTNERS OF THE SELECTED CRAFT – A BRIEF ACCOUNT BASED ON THE SURVEY RESULTS	66
7.5. RELIABILITY OF THE SUCCESS PERCEPTION OF SMES PARTICIPANTS REGARDING TO THE CRAFT IN ANALYSIS – A PRELIMINARY ASSESSMENT.....	69
7.6. RELIABILITY OF THE SUCCESS PERCEPTION OF SMES PARTICIPANTS REGARDING TO THE CRAFT IN ANALYSIS – A MORE SYSTEMIC VIEW BASED ON THE QUESTIONNAIRE	69

7.7. LOOKING FOR WAYS TO IMPROVE CRAFT OUTCOMES – THE PARTICIPANTS PERSPECTIVE	73
PART IV – MAIN CONCLUSIONS AND POLICY CONSIDERATIONS FOR THE DEVELOPMENT OF PUBLIC R&D INSTRUMENTS TARGETING SMES	77
CHAPTER 8. MAIN CONCLUSIONS AND POLICY CONSIDERATIONS.....	78
REFERENCES.....	80
APPENDIX.....	94
APPENDIX 1. BOUNDARIES OF R&D	94
APPENDIX 2. PAVITT’S CLASSIFICATION	96
APPENDIX 3. CONVERSION OF ‘WELL-SUCCEDED’ CRAFTs INTO SIC, OECD AND PAVITT TAXONOMIES, BASED ON ORIGINAL NACEs AND SUPPORTING TECHNOLOGIES	97
APPENDIX 4. QUESTIONNAIRE CONSTRUCTED FOR SURVEYING CRAFTs’ PARTICIPANTS	99

List of Tables

Table 1: Firms R&D investments and performance	10
Table 2: Motivations for being involved in R&D cooperation.....	14
Table 3: Instruments aimed at generating, demonstrating and validating new knowledge through R&D	29
Table 4: Instrument aimed at the durable integration of the participants' research activities/capacities	30
Table 5: Instruments aimed at supporting collaboration and coordination and other activities (such as conferences and studies).....	31
Table 6: Characteristics of CRAFT projects.....	33
Table 7: Number of projects involved in the CRAFT program.....	36
Table 8: Number of projects involved in the CRAFT program.....	37
Table 9: Industry distribution of well-succeeded CRAFTs	38
Table 10: Classification of 'well succeeded' CRAFTs according to the Pavitt's taxonomy	40
Table 11: Technology table –OECD classification of industries by level of technology	41
Table 12: 'Well succeeded' CRAFTs classification following OECD taxonomy	43
Table 13: Main characteristics of well-succeeded CRAFT projects	46
Table 14: Descriptive statistics and correlation matrix	55
Table 15: Estimation results (dependent variable: promoter identity index or 'cultural' proximity)	57
Table 16: Estimation results (dependent variable: average promoter-participant distance or 'geographical distance')	58
Table 17: General characteristics of the selected CRAFT	64
Table 18: Frequency (0: never; 1: sometimes; 2: often), and type of contacts between partners <i>during</i> the project.....	67
Table 19: Classification of the level of cooperation between partners (0: inexistent; 1: very poor ... 5: very good).	67
Table 20: Classification of the level of difficulty (0: easy ...5: very difficult) of some factors in the relation with the other partners	68
Table 21: Frequency of contacts (0: no contact; 1: sometimes; 2: often), and type between partners (national and international) <i>after</i> the end of the project	68

Table 22: Importance attributed to the different potential reasons for engaging in R&D international cooperation (CRAFT) (1: no importance ... 5: very important)	70
Table 23: Impact of CRAFT participation on SMEs' product/process development – degree of agreement (0: not agree at all ... 5: absolutely agree)	71
Table 24: Results of the selected CRAFT project	71
Table 25: Degree of agreement concerning the cooperation relationship within the selected CRAFT (0: not agree at all ... 5: absolutely agree)	72
Table 26: The perception of CRAFT participants on the benefits accrued to the organization	73
Table 27: Classification of some aspects related with CRAFT projects	74
Table 28: Factor importance for a successful cooperative relation (0: not important ... 5: extremely important).....	75
Table 29: Boundaries between R&D and education and training at ISCED level 6	94
Table 30: Some cases at the borderline between R&D and other industrial activities...	95
Table 31: Pavitt taxonomy	96
Table 32: Authors' conversion of original projects NACEs into SIC, OECD and Pavitt taxonomies	97

List of Figures

Figure 1: Number of SMEs performers by country	44
Figure 2: Regional distribution (NUTS I) of well succeeded CRAFTs	45

Introduction

Technology-based Small and Medium Enterprises (SMEs) are usually seen as key component in the innovation system, facilitating the emergence of new products and markets. Notwithstanding, low and medium-tech SMEs, with little or no research capability, are increasingly in the need to reinforce their knowledge and research intensity, expand their business activities into larger markets, and internationalize their knowledge networks. Inter-firm collaboration, namely in R&D, emerges as an important contributor for these SMEs to overcome their handicaps.

Public support programs to promote R&D cooperation have been implemented in the last two decades in the most developed countries, for instance in the US, Japan and the European Union (EU) countries.

The emergence and growing importance of the EU support programs for increasing firms' R&D, especially the SMEs, have been one of the solutions adopted by countries to improve their position on the rankings related with the R&D and innovation, as defined by the Presidency of the European Council conclusions of their meeting in Lisbon (March, 2000), commonly known as the Lisbon Strategy. The European Union's successive Framework Programs (FPs) are a noteworthy example (Busom and Fernández-Ribas, 2004). Such programs aim at enhancing the performance of member countries, their organizations and citizens concerning R&D and innovation.

To bridge SMEs and R&D the most recent FP (FP6) defines an autonomous instrument to enhance SMEs' technological capacity, named CRAFT (Cooperative Research Action for Technology). This program is not new, but in the former FPs was part of other programs (e.g., BRITE-EURAM, ESPRIT IV or FAIR). The new visibility and promotion to this tool by the EU reflects the increasing importance attributed to the need for improving their low tech SMEs' innovation capabilities.

Although a considerable amount of empirical evidence on inter-firm collaborations within technology-based industries exists only a few works concerned with R&D cooperation by low-tech firms, especially SMEs, are known (an exception is Delgado et al., 2005). In the present thesis one of our main objectives is to add further and detailed empirical evidence on this scarcely tackled area.

Alongside to the intensifying trend toward formalized cooperation, namely through inter-firm alliances, joint ventures, and R&D and other agreements (Powell and Brantley, 1992), several authors (e.g., Porter, 1990; Krugman, 1994) have empirically and theoretically made the case for the benefits of geographical proximity, or the location of firms in regional agglomerations (Storper, 1995). Proximity is said to enhance the performance of the firms through knowledge spillovers, informal information exchange, and the easier availability of inputs, skills, and other shared resources (Scott, 1992; Harrison et al., 1996; Rosenkopf et al., 2001). Both these phenomena (cooperation and proximity) reflect the accelerating pace of innovation, and the related requirements of staying abreast of technological and market trends, integrating relevant knowledge, and developing new products and processes (Lundvall, 1992).

Recent studies (Fristch, 2003, Doloreux, 2004; Kingsley and Malecki, 2004) gather evidence that localized external networking is less prevalent than might have been expected. In fact, in many instances, regional networks for technological development are not the most predominant ones (Doloreux, 2004). Moreover, proximity does not seem to be an important factor in shaping the structure of informal networks or the use of information (Kingsley and Malecki, 2004). This evidence concludes that the importance of proximity has in fact been overestimated. It further demonstrates that SMEs make use of a mixture of local/regional, national and even international knowledge sources, and that their ability to sustain networks at different regional scales is a key factor in competitiveness and innovativeness.

There is thus a pressing need to develop a more refined line or argument that breaks with the current view on the localized character of innovation in order to provide a deeper understanding of other similar forms of linkages which are more dispersed in space. In Bunnell and Coe's (2001: 570) words, there is a "... need for a qualitative shift away from work which focuses on particular scales as the locus for understanding innovation, towards that which gives more credence to relationships operating between and across different scales." Such re-focusing would lead to both theoretical enrichment and new practical applications in public policy with regard to innovation networks.

It is therefore apparent that while a large number of studies in economic geography has emphasized the spatial proximity and clustering of economic activity and its relation to the spatiality of knowledge creation in various types of connections, far less attention

has been paid to the understanding of the determinants of ‘cultural’ and geographical proximity in international R&D cooperation projects. Furthermore, as Fritsch (2003) recognizes, not much is known about the significance of interregional differences in the propensity of enterprises to cooperate, and the relationship between cooperation behavior and the quality of the regional systems of innovation (RSI).

The present study seeks to address some of these gaps by providing some results on formal international R&D networks comprising SMEs and R&D institutes. In particular, it tries to assess the effect of technological complexity, project size, and the strength of the regional systems of innovation (RSI) on the cultural and geographic proximity of network participants.

For pursuing this goal we use a database constructed by us, which encompasses 118 projects (CRAFTs), from the 3rd to the 5th FP, involving 791 SME from 21 countries. The CRAFTs involve consortia of SMEs from different countries, with low or medium technological capacity and few research abilities, to entrust research and development activities to scientific institutions (Universities or Research Institutes), while owning the results. This program has characteristics (SMEs cooperate simultaneously with others from the same country and from other countries) that provide precious data that allows the test of the controversial role of (geographical and cultural) proximity in innovation (Sternberg, 1999).

Despite CRAFT’s increasing popularity and promotion, its evaluation results are non-existent. To countervail such ‘no one’s area’, we further seek to provide some rough and preliminary evidence of the adequacy of such ‘success’ criterion; comparing perspectives both from the evaluator (EU) and the participants (SMEs).

Summarizing the main research questions of the present investigation are:

- 1) What is the relationship between technology and (cultural and geographical) proximity in international R&D networks?;
- 2) What are the main determinants of cultural and geographical proximity in international R&D cooperation?; and
- 3) Does R&D cooperation between low tech firms involve the ‘de-territorialisation of closeness’?

In order to answer these questions, the content of the thesis is outlined as follows. In the first part of the thesis (Part I) we overview the literature on cooperation, R&D, knowledge creation and appropriation (Chapter 1), and discuss critically the conceptualization of geographical, cultural and technological proximity between firms (Chapter 2). Such literature review permits to uncover the main gaps to be filled in the existing literature about the cooperation between SMEs with few technological capabilities (Chapter 3). Part II of the thesis provides an overview of existing European policies to promote SMEs R&D capabilities, with special focus on CRAFTs. Here we analysis of different instruments available and their goals (Chapter 4) and supply a detailed account of the CRAFT program, with an emphasis on ‘successful’ projects (Chapter 5). In Part III, Chapter 6 develops the theory and presents empirical evidence on Regional Systems of Innovation (RSI), cooperation and networking and then Chapter 7 details the empirical analysis of successful R&D alliances by outlining some essential features of CRAFT projects, setting the econometric specifications and presenting the results. Based on case study methodology, in Chapter 8 we put forward some preliminary and qualitative assessment regarding SMEs’ perception on CRAFT projects’ success. Finally, Part IV systematizes the main conclusions and policy consideration for the development of public R&D instruments targeting SMEs.

Part I – Literature review on inter firm cooperation and the role of proximity

Chapter 1. R&D, knowledge creation and appropriation.

Systematizing the relevance of R&D cooperation for SMEs

1.1. Concepts of R&D

It is not easy to find a consensual definition for *Research & Development* (R&D). The theme has been object of study by several organizations and researchers due to its relevance for both scientific studies and firms' accounting procedures, which permit to do coherent comparative analysis between countries, sectors, firms, etc.

The *Frascati Manual* (OECD, 2002), document created by the Organization for Economic Co-Operation and Development (OECD) in 1961, with successive revisions until 2002, is the most widely used by all that are interested in this subject. Its rules are followed, for example, by the *United Nations Educational, Scientific and Cultural Organization* (UNESCO) and the *European Union* (EU) in order to identify and measurement of R&D activities by organizations of all types.

This document defines R&D activities as (OECD, 2002: 30)

... [the] creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

However some kind of activities such education, formation, some scientific, technological, industrial, administrative and support activities, directly connected to R&D, by information flows, operations, institutions and personnel, should not be accounted as R&D activities, because their direct goal is not the referred "new applications". It is suggested a basic criterion to distinguish R&D from the other activities (OECD, 2002: 34)¹

...the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty, *i.e.* when the solution to a problem is not readily apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned.

¹ In Appendix 1 we provide summaries tables (29 and 30), which include examples that enable a better understand of the boundaries of R&D activities.

R&D activities can have different purposes that are important to identify because their distinction permits in general (but not always) to determine the stage of knowledge from the object of study by the researchers: between embryonic and advanced. This identification drives us to another classification: *basic* (or *fundamental*) and *applied* research. Ettlie (2000: 133) defines both in the following terms (emphasis added):

The aim of the *fundamental* or *basic* research is the knowledge or the understanding of the subject under study, before its practical application, i.e., doesn't have a specific commercial purpose, although this research could satisfy a potential interest of the company for it responsible (...)

(...) *Applied* research is targeted to the profits: necessary knowledge or understanding to determine the means to satisfy a known and specific need, i.e., the discovery of new scientific knowledge with specific commercial aims, related with products or processes.

Both types of research are important and complementary and we can conclude that research is an iterative process, where new knowledge can drive to new applications, these can generate new doubts that origin new research and so on.

In these definitions the word *knowledge* appears often with different meanings, such as *common knowledge*, *stock of knowledge*, *knowledge of man, culture and society*. It is important to understand and conceptualize their significance to determine their relevance for R&D in general and the R&D cooperation in particular.

1.2. Knowledge, human resources and R&D

Most of the cooperation relationships between people or organizations involve and are based on tacit and codified knowledge diffusion. Following Cowan et al. (2000: 217, cit. in Balconi, 2000: 360):

(...) humans (and other live creatures) know things that were not realized as information and that were not reduced to symbolic representations (code), they are kept on a way that doesn't permit the communication, in a write way, to others (at least not explicitly as information structured messages).

Based on the above statement we may define, although in a simple and rude way, *tacit knowledge* as the one acquired by people or organizations, through the experience on task execution and on problem resolution and that couldn't be acquired through a formal education (Bateira, 2005). From this definition we can extract, by opposition, the concept of *codified knowledge*, i.e., the one that is symbolically translated in a way that can be widely spread, appropriated and used.

On practical terms, the dichotomy between tacit and codified is not always easy and knowledge has generally both components (Bateira, 2005).

Recalling once more the Frascati Manual (OECD, 2002), the investments made to qualify human resources should not be all classified as R&D, neither their activities. However they are fundamental as creators, addressees, users and spreaders of knowledge. They also represent one important resource that any organization and firms in particular need to manage for achieving their goals.

In *Canberra Manual's* (OCDE, 1995: 3) preface, document that follows the same philosophy of the Frascati Manual, but conceived for measuring the human resources devoted to science and technology, the relevance of this *input* for R&D activities is clearly put forward:

Highly skilled human resources are essential for the development and diffusion of knowledge and constitute the crucial link between technological progress and economic growth, social development and environmental well-being.

In fact, it is unanimously accepted that those individuals that are more informed and educated can more easily create new knowledge (OCDE, 1995; Teixeira, 2002). In this context, firms on their own or from others R&D activities, try to get and apply *new* knowledge to achieve new or better products or processes (i.e. innovations) that they expect that would improve their commercial performance (Bougrain and Haudeville, 2002). In this same line of argumentation, Bóia et al. (2004: 30) refer (author's translation):

Beside individual creativity and initiative, the growth of productivity depends on firms "creativity" to catch the several possibilities of change in order to produce more efficiently higher value added goods and services. In one word, productivity growth is determined by technological innovation. For example, is verifiable that technology intensive firms increase productivity and employment. Firms that execute R&D and that adopt new technologies (particularly information technologies) have above average productivity results.

Basic R&D is often executed by public organizations or similar (governments, universities and other no-profitable organizations). In this situation, the R&D outputs assume a 'quasi-public' good nature, benefiting communities, through their knowledge base enlargement, and particularly some agents like firms, powering the efforts of more applied R&D.

Humans are simultaneously the source and destination of knowledge and as one firms' resource they can have a strong influence on their performance and ultimately in countries' economic growth. Indeed, according to Teixeira and Fortuna (2004: 218):

... human capital is extremely important for (...) economic growth, directly, through its impact on productivity and indirectly, by facilitating the absorption of new knowledge thereby enhancing the impact of new knowledge on productivity.

We may argue that R&D is one process to transform tacit into codified knowledge (Steinmueller, 2000) and also to create new knowledge, easing their dissemination and potentially improve populations' general skills and performance. Firms can profit, directly or indirectly, from these skills through human resources actions and knowledge application.

1.3. Overcoming costs of R&D knowledge creation and taking advantage from it through cooperation

With the growing competition between countries and firms, the monetary, fiscal, legal and economical tools, previously used by governments to protect their markets, almost disappeared or are today very limited. This situation motivates the necessity of firms mark the difference against the competitors, through the creation of new products (or versions), services or processes and the productivity improvement of their available resources. R&D activities can be a way to achieve these goals, as some authors consider that firms engaged on these activities are more innovative (Cohen and Levinthal, 1989; Asheim and Isaksen, 2002).

In Table 1 we summarize some evidence on the effects of R&D activities that firms might hope to achieve with their investments in this area. The main ideas conveyed in the table are four-fold. Firstly, that knowledge creation is important to improve firms' knowledge stock that may lead to sophisticated products, services or processes, with better margins. Secondly, knowledge absorptive capacity improvement is important to profit from knowledge spillovers and to use knowledge stock in new applications, i.e., people can use only what they understand. Thirdly, innovations in products, services or processes can directly drive to competitive advantages against competitors. Finally, some results are expected with a better productivity of firms' results.

Table 1: Firms R&D investments and performance

Investment in R&D and firms' ...:	Correlation	Studies
... knowledge creation.	+	Cohen and Levinthal (1989); Boschma (2001); OECD (2002); Teixeira (2005)
... knowledge absorptive capacity improvement.	+	Cohen and Levinthal (1989); Boschma (2001); Teixeira (2005)
... innovation in products, services or processes.	+	OECD (2002); Becker and Dietz (2004); Teixeira (2005)
... improvement in productivity.	+	Bóia et al. (2004)

If R&D brings so satisfactory returns, why do not all firms invest on it? One reason is reflected on Balconi's (2000: 361) words: "(...) codification cost is related with production scale (...) [and] codification profits are positively related with the intensive use of such codified information (...). Consequently, [mainly] small firms can consider codification no profitable and prefer to depend on tacit knowledge of their employees."

This statement drives us to another question: Are there solutions or strategies to overtake the above mentioned difficulty and improve SMEs' R&D capabilities and, consequently their knowledge and performance?

Although knowledge codification costs may be high, those of their reproduction tend to be marginally low. Knowledge codification facilitates the technology transfer and externalization of that same knowledge, permitting outsourcing activities, which benefit other firms through the acquisition of new knowledge at a (but not necessarily) lower cost (Cohendent and Steinmueller, 2000). These firms can acquire new knowledge yet no totally codified (or that will be with difficulty and/or at a reasonable cost), through the sharing of experiences with other companies. In other hand, they can codify knowledge, sharing task costs, through specifically R&D cooperation. Thus, R&D cooperation might constitute a solution, particularly to SMEs that lack resources and scale economies, to get and codify knowledge.

1.4. The growing trend towards R&D cooperation. The particular case of SMEs R&D cooperation

In recent years, there has been growing interest in cooperative arrangements for innovation. Some commentators, such as Teece (1992), have argued that the rise of these relationships has overturned our existing understanding of the organization of

innovation, i.e., is seen as becoming increasingly distributed, as fewer firms are able to 'go it alone' in technological development (Tether, 2002). Indeed, most innovation activities involve multiple actors (Becker and Dietz, 2004). The development of new and improved products rather requires an active search-process involving several firms and institutions to tap new sources of knowledge and technology (von Hippel, 1988; De Bresson, 1996; Nooteboom, 1999). The exchanges of information and resources with different partners are important factors in the innovation process.

Over the last twenty years in OECD countries cooperative agreements to perform R&D activities have indeed been increasing: the share of patent co-applications in triad patent families has almost doubled since 1980, and the number of strategic technology alliances has almost tripled on average (OECD, 2002). This trend is also documented by Hagedoorn et al. (2000). The Community Innovation Survey (CIS), conducted in EU member countries, provides additional evidence on the importance of R&D partnerships and its variation across firms, industries and countries. According to CIS3, on average 17% of manufacturing firms with innovative activities indicate they had cooperation agreements in 1998-2000; the share is significantly higher for large firms (61%). Partnerships with suppliers or customers are as frequent as partnerships with universities. Cross-country differences are significant: in Finland, 22% of SMEs in the manufacturing industries declared being involved in cooperative agreements in 2000, while in Spain or Italy barely 3% of SMEs did (Busom and Fernández-Ribas, 2004).

Accompanying these trends of more intense cooperation relationships, public policies towards the framing of R&D consortia are becoming more favorable (Martin, 1996). These developments, whether they are called R&D alliances, R&D consortia, strategic technology partnerships, or simply collaborative innovation networks, are the subject of a growing scholarly literature (Levy and Samuels, 1991; Hagedoorn, 1996; Vonortas, 1997; Hagedoorn et al., 2000).

Firms that engage in innovation activities are aware of the necessity to establish R&D cooperation, to obtain expertise which can not be generated in-house (Becker and Dietz, 2004). Such cooperation, defined as collaboration, intends to achieve a common goal, which is to develop new and improved products (technologies). Within a more or less durable collection of agreements between two or more partners, assets and activities are pooled, and combined. Thus, technological capabilities to develop product and process innovations can be improved. For instance, Teece (1986: 293) notes that "[it] is well

recognized that the variety of assets and competencies which need to be accessed (for innovation) is likely to be quite large, even for modestly complex technologies. To produce a personal computer, for instance, a company needs access to expertise in semiconductor technologies, display technology, disk drive technology, networking technology, keyboard technology and several others. No company can keep pace in all of these areas by itself". According to this 'complexity thesis', collaborations are particularly common when the technologies being developed are new or rapidly evolving, complex and/or expensive to develop, and when the market is poorly defined. By engaging in R&D alliances, firms are able to obtain the complementary technology, achieve economies of scale in R&D, and monitor the competitors (Powell, 1987; Burgers et al., 1993).

The reasons why firms in the advanced countries seek to pool their development efforts within R&D consortia, and the nature of the benefits they derive, is presently the subject of a burgeoning international literature (Mathews, 2002). The theoretical economic arguments (Spence, 1984; Katz and Ordover, 1990; Kamien et al., 1992) tend to focus on the "spillover" effects of R&D, creating a socially useful externality. According to this reasoning, firms enhance social welfare through their research activities, but this may depress their incentives to continue, unless a form of R&D collaboration can internalize such an externality. These arguments are of necessity couched in cost terms, with consortia seen as pooling costs, and with the inevitable assumptions that vitiate much economic reasoning, e.g. that cooperation either involves all firms in an industry or none (compared to the reality that cooperation usually involves a small subset of firms).

More comprehensive explanations for consortia formation and governance have come from the institutional economic literature and strategic management literature (Mathews, 2002). Here, the focus has been on matters such as how firms formulate and achieve strategic goals through the formation of research consortia (Link and Bauer, 1989; Martin, 1996; Vonortas, 1997); how firms and agencies combine to enhance their resource base (Mowery et al., 1998); and how they can actually manage the complex processes of building inter-firm collaborative routines (Powell et al., 1996; Sakakibara, 1997a,b; Doz et al., 2000; Sawhney and Prandelli, 2000). These strategic goals, include gaining access to technical capabilities not otherwise easily accessed, particularly,

complementary technological resources, which generate new business opportunities (Link and Bauer, 1989; Vonortas, 1997).

The creation of value, through inter-organizational relationships and the capture of “relational advantage”, has too become a topic for sustained inquiry (Child and Faulkner, 1998; Dyer and Singh, 1998; Saxenian, 1991; Barringer and Harrison, 2000). As referred above, SMEs in particular have been able to take advantage of R&D consortia in order to overcome diseconomies of scale (Sigurdson, 1986, 1998; Kleinknecht and Reijnen, 1992). The aim is to enhance the firms’ absorptive capacity, thus, giving them potential access to a wider range of technological options (Cohen and Levinthal, 1989).

Summarizing and following the course of an innovation process, from invention or scientific development through to the introduction of new products in the market place (Hagedoorn, 1993; Bayona et al., 2001), we might assembly the motivations for cooperative R&D into three main groups (cf. Table 2): complexity of technological development; the reduction and sharing of uncertainty and costs; and market access and the search for opportunities.

Almost all the aspects related to the motivations of firms for R&D cooperation have been subject of study (Table 2). Researchers seem to be interested in what drives firms to adopt such strategies and the corresponding outcomes. The goals of these studies seem to be of two sorts: in one hand, to provide relevant information for the design of efficient public policies; and, on other hand, to understand the critical factors of the complex process of R&D cooperation that can be used (or avoided), at the firm level, to achieve ‘better’ results.

In a closer analysis of what are the firms’ motivations for R&D cooperation (see column ‘details’ in Table 2), we can have a sight of their diversity and easily understand why is so difficult to define ‘standard’ policies that serve all these purposes.

Table 2: Motivations for being involved in R&D cooperation

Motivations		Details	Studies
<i>Basic and applied research → general characteristics of technological development</i>	<i>Complexity of technological development</i>	Access to new technological knowledge and to complementary technologies, which allow for different research lines to be followed.	Hladik (1985); Link and Bauer (1989); Hagedoorn (1993); Wang (1994)
		Achieve scale and scope economies and to respond rapidly in the market place despite the technological uncertainty	Teece (1992); Häusler et al. (1994); Hagedoorn and Narula (1996); Katz and Martin (1997); Tidd (1997); Robertson and Gatignon (1998)
		Alliances as an intermediate governance mechanism between the market and the hierarchy. The more complex is the existing technology, the more inefficient is the market as the place in which firms can acquire the necessary knowledge and technology.	Shing (1997); Robertson and Gatignon (1998)
		The possibility of acquiring and internalizing the abilities and competence of the partners, in order to create new valid competence for the firm.	Hamel (1991); Steensma (1996)
	<i>The reduction and sharing of uncertainty and costs</i>	By combining their efforts, firms can reduce the uncertainty derived from the expected result not being obtained, not appearing with sufficient speed, or requiring more financial or technological funds than were originally expected and increase the possibilities of obtaining a positive result.	Porter and Fuller (1986); Hladik (1988); Dodgson (1992a); Hagedoorn (1993); Tsang (1998)
		The probability of an innovation enjoying success also depends on aspects such as the complementarity of the resources and the increase in R&D investments, which is favored by cooperation.	Sinha and Cusumano (1991)
		As demands, preferences and needs of consumers change at great speed, the excessive period of time that may pass between the invention of the product and its final appearance in the market also supposes a high risk for the firm and thus one objective is to shorten it.	Hladik (1988); Dodgson (1992a); Hagedoorn (1993); Häusler et al. (1994)
		Help to avoid the duplication of unnecessary R&D efforts and to achieve scale economies.	Porter and Fuller (1986); Dodgson (1992a)
	<i>Market access and the search for opportunities</i>	To absorb the knowledge and abilities which they lack and which is represented by the tacit knowledge of their partner, that is to say, its know-how, both in the area of technology and in other aspects.	Teece (1992)
		Aim at extending the range of products, or substituting those that already exist because they are found in mature sectors.	Hagedoorn (1993)
		Access to larger domestic and foreign markets, thereby improving their expectations of recovering the investment.	Hladik (1988); Dodgson (1992a,b); Hagedoorn (1993); Sakakibara (1997a,b)
		The standardization of products or processes, aiming at excluding possible competitors by implementing a strategy based on differentiation or cost advantages that will act as a barrier to the entry of new firms in the sector.	Porter and Fuller (1986); Hladik (1988); Dodgson (1992a); Hagedoorn (1993); Miyata (1996)

In the emergence of some R&D networks, especially in cases that interdependencies are difficult to recognize (Sandoz, 1992; Corey, 1997), the existence and legitimacy of a triggering entity is likely to be critical (Doz et al., 2000). In cases where technologies

are not as well specified, or where tacit know-how is to be employed, triggering entities may be required (Ring and Rands, 1989). A legitimate triggering entity may be required to lessen the concerns of potential participants that the costs and benefits of collaboration will be shared ‘fairly’ (Browning et al., 1995). The triggering entity role has been played by governmental agencies (e.g., Kurozumi, 1992; Sandoz, 1992). Individuals acting as champions (e.g., Hausler, Hahn and Lutz, 1994) or specific firms (e.g., Hakansson and Shehota, 1995; Lorenzoni and Baden-Fuller, 1995) constitute other clearly identifiable triggering entities.

In the case of CRAFTs projects, analyzed later (Part II) in this study, Research and Technology Development (RTDs) performers present actually a similar role to those ‘triggering entities’.



The specificities of firms (e.g. geographic localization, culture, cognitive capacity) seem to affect the affinities (proximities or distances) between them. They tend to be considered as critical factors which can influence the type and ‘success’ of firms cooperation relationships. In the next chapter we analyze how proximity/distance, in its different perspectives (geography, culture and technology), is relevant for R&D cooperation.

Chapter 2. Critical discussion around the conceptualization of geographical, cultural and technological proximity between firms

2.1. Defining geographical, cultural and technological proximity

The literature on the importance of proximity in innovation networks and cooperation, is presently flourishing. Recently, it has been conveyed that although spatial proximity facilitates interaction and cooperation, it is not a prerequisite for interactive learning to take place (Malecki and Oinas, 1999). Due to advanced information and communication technologies (ICTs), networks through which learning takes place are not necessarily spatially delimited.

In a study on research projects, Rallet and Torre (1999) showed that tacit knowledge might be transmitted across large distances through other forms of proximity. They demonstrated that the need for geographical proximity is rather weak when there is a clear division of precise tasks that are coordinated by a strong central authority (organizational proximity), and the partners share the same cognitive experience (cognitive proximity). In fact, for some authors (e.g. Torre and Gilly, 2000) proximity means a lot more than just geography, covering a number of dimensions, namely technology and institutional/cultural proximity.

While geographical proximity is defined as spatial distance between actors, both in an absolute and relative meaning, technological proximity involves the work in the same domain or cognitive area (Sorenson et al., 2004; Boschma, 2005b) and institutional/cultural proximity accounts for the fact that interactions between players are influenced, shaped and constrained by the institutional environment (Kirat and Lung, 1999; Boschma, 2005b).

By institutions we mean “... sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals and groups” (Edquist and Johnson, 1997: 46). Thus, the notion of institutional/cultural proximity includes both the idea of economic actors sharing the same institutional rules of the game, as well as a set of cultural habits and values (Zukin and Di Maggio, 1990). Formal institutions (such as laws and rules) and informal institutions (like cultural

norms and habits) influence the extent and the way actors or organizations coordinate their actions. In this sense, institutions are enabling or constraining mechanisms that affect the level of knowledge transfer, interactive learning and (thus) innovation (Boschma, 2005b). A common language, shared habits, a law system securing ownership and intellectual property rights, etc., all provide a basis for economic coordination and interactive learning. A culture of shared trust, for example, is often regarded as a capability that supports learning and innovation: information is transmitted more easily with cultural proximity and a common language (Maskell and Malmberg, 1999). In short, institutional, or more restrictively, cultural proximity is an enabling factor, providing stable conditions for interactive learning to take place effectively.

2.2. The specificity and relevance of geographical proximity for innovation

An academic debate has been growing over the last decade on how tacit and codified knowledge can mediate the effect of distance on knowledge sourcing. As we referred above, “tacit knowledge refers to knowledge which cannot be easily transferred because it has not been stated in an explicit form” (Foray and Lundvall, 1996: 21), while codified knowledge – or ‘information’ – is reduced to messages which can be easily transferred between economic agents through nonhuman supports.

It is assumed then that codified knowledge can be exchanged regardless of distance by using technologies of communication, be them old (postal mail) or new (electronic mail, computer conferencing) (Koschatzky et al., 2001). At the opposite, the transfer of tacit knowledge requires a sharing of common work experience through face-to-face relations (Maskell and Malmberg, 1999; Doloreux, 2004). As a consequence, geographical proximity appears as a necessary condition for an efficient share of knowledge, especially in the case of tacit knowledge intensive activities.

The renewed interest in tacit knowledge is largely due to its perceived social and spatial significance when learning and innovation are at premium (Storper, 1997): socially, because tacit capabilities like team skills and organizational routines constitute the core competence of firms; spatially, because tacit knowledge, being person-embodied and context dependent, is locationally ‘sticky’, a characteristic which helps to explain the clustering of knowledge intensive activities (Maskell et al., 1998; Gertler, 2001). As we

referred in Section 1.2., tacit knowledge encompasses knowledge that cannot be articulated, being captured by Polanyi's (1966) famous statement, "we can know more than we can tell". Contrasting with tacit knowledge, explicit or codified knowledge covers a formalized knowledge that can be transferred in a depersonalized manner through technical blueprints and operating manuals, etc. Being personal and context-dependent, tacit knowledge represents disembodied know-how that is acquired directly through interactive learning (Howells, 1996).

Antonelli (1999) and Roberts (2000) argue that modern information and communication technologies (ICTs), which lower the costs of codifying knowledge, and stronger intellectual property rights, are reducing the importance of short distances to access tacit knowledge while simultaneously increasing the ability of firms to obtain knowledge from outside the firm. Conversely, Senker (1995) proposes that most rapidly developing and complex technologies will always depend on tacit knowledge and, consequently, on close, inter-personal interactions to share knowledge. This will hold even when knowledge can be codified, as long as there is a delay between its discovery and its codification. In this context, distance could matter because local, direct, personal contacts allow a company faster and more successful access to knowledge gatekeepers, to discover where and how to access new knowledge (Arundel and Geuna, 2004).

In the same line, other authors (e.g., Morgan, 2004) tend to reject the possibility that effective transfer of tacit knowledge can be consummated at a geographical distance. Within these stream, a large body of literature claims that agents, that are spatially concentrated, benefit from knowledge externalities. Short distances bring individuals together, favor information contacts and facilitate the exchange of tacit knowledge. Accordingly, the larger the distance between agents, the lower the intensity of these positive externalities, and the more difficult it becomes to transfer tacit knowledge. This may even be true for the use and spread of codified knowledge (although often stated otherwise), because its interpretation and assimilation may still require tacit knowledge and, thus, spatial closeness (Howells, 2002).

Several empirical studies (e.g. Jaffe et al., 1993; Audretsch and Feldman, 1996) tend to confirm that knowledge externalities are geographically bounded: firms near knowledge sources show a better innovative performance than firms located elsewhere.

Other authors (Fristch, 2003; Doloreux, 2004; Kingsley and Malecki, 2004) challenge the idea that geographical proximity matters almost automatically in this respect. Such

authors stress the importance of ‘communities of practice’ that produce, acquire and diffuse knowledge through the use of digital technologies and ‘temporary’ physical proximity associated with business travel (Breschi and Lissoni, 2002).

Some available empirical studies of SMEs’ innovation and networking activities show that a firm’s innovation networks do not always hinge on geographical proximity (e.g., Britton, 2003; Doloreux, 2003, 2004). Some studies support the rejection of simple models of spatial clusters and localized learning where internal connections are privileged over interregional and international transactions operating either between or within firms. In a study of Toronto’s electronic cluster, Britton (2003) argues that knowledge and material inputs, and other knowledge sources of this industry provide both interregional and international sources of specialized inputs. In other study on the spatial patterns of networks of traditional manufacturing firms in Québec, Doloreux (2003) shows that cooperative partners of SMEs in innovation are distributed over various regional levels and, to be innovative, SMEs need to take advantage of international sources of specialized inputs. This is not dissimilar to the findings of Larsson and Malmberg (1999), who conclude in their study of the Swedish machinery industry, that local networking has not a positive impact on the performance of firms. Suarez-Villa and Walrod (1997) reinforced the earlier finding by arguing that spatial clustering has not lead to greater opportunities for innovation and technological development in the electronic industries of California. Analyzing a set of firms in Ottawa, Doloreux (2004) finds that overall, localized external networking was less prevalent than might have been expected. Indeed, the importance of proximity was not substantiated: firms make use of a mixture of local/regional, national and even international knowledge sources, and that their ability to sustain networks at different regional scales is the key for the competitiveness and innovativeness of SMEs.

2.3. Beyond geography: the plead for cultural proximity in cooperative inter firm relations

Most of the literature on networking and innovation tends to highlight the role of both physical (geographical) and cultural proximity, stressing the quality of the territory as a determinant in the performance of firms and the local/regional economy (Lundvall, 1992; Storper, 1995; Lorenzen, 1998). Indeed regional innovation networks require conditions beyond mere physical proximity and concentration to thrive (Gegersen and

Johnson, 1997). As Regional Systems of Innovation (RSI) literature argues, the spatial proximity of innovation networks is also tied to a common social and cultural understanding, without which the relationship between close agents can be hindered (Braczyk et al., 1998). So, proximity is not just an issue of geography, but equally of the degree to which economic, organizational, relational, social and cultural realities are shared. In this sense, 'cultural' proximity might be as (or more) relevant than physical proximity.

Koschatzky and Sternberg (2000) claim that especially for manufacturing SMEs, the border, and thus the different institutional system, language and culture act as a major barrier for information and knowledge exchange. The absorptive capacity or, as Cooke and Morgan (1998) put it, the associational capacity of firms, does not seem to enable them to enter and handle networks with partners from other countries on a large scale. Moreover, Koschatzky's (2000) study shows that a different situation holds true for networking among research institutes: national borders play a much less important role in scientific collaboration. It can thus be concluded that spatial proximity might be a prerequisite for certain kinds of innovation networks within national boundaries, i.e. innovation systems, but is outweighed by cultural and institutional distance when spatially close knowledge sources are divided by a national border.

The importance of interaction in innovation processes also makes it clear that networking is an essential means of knowledge exchange and learning (Doloreux, 2004). Contemporary innovation theories emphasize the interactive practice of innovation and the relation between firms and their environment. According to such innovation processes, they are not isolated in their origins, but rely on a variety of factors, internal and external to the firm (Kline and Rosenberg, 1986; Edquist and Hommen, 1999). External relations formed with other producers, suppliers, universities, research institutes and local support organizations can be the source of new ideas for innovation (Costa and Teixeira, 2005). As a result, innovative networks have become a persistent organizational phenomenon in industrial organization processes (Doloreux, 2004).

We might therefore conclude that cultural aspects are relevant for firms' interrelationships having a non negligible influence on cooperation. Notwithstanding, cultural proximity can be achieved with geographical distant partners. As Beugelsdijk

and Cornet (2002) say, in innovation cooperative relations “a far friend might be worth more than a good neighbor”.

2.4. The odd role of technological proximity in innovation cooperative relations

According to Sorenson et al. (2004), there is technological proximity between two or more firms when they work in the same technological domain. This proximity, together with spatial proximity - when firms have any kind of links between them -, can generate agglomerations or industry clusters (Rallet and Torre, 1999; Lublinsky, 2002; Bell, 2005). Some reasons for this phenomenon are the flows of knowledge (spillovers and other types) and people between them boosted by geographical proximity. For instance, economic success of some regions (e.g., Silicon Valley, Route 128 and Third Italy), with innovative firms, which dominate technological knowledge in some specific areas (Pyka, 1999), has been subject of study by several researchers (e.g. Saxenian, 1991) and has inspired a considerable number of governments’ policies to “produce” similar regions.

The result of a study conducted by Orlando (2000) to determine the relation between geographical and technological proximities, suggests that “... the importance of geographic proximity may be driven by the propensity of similar industrial activity to agglomerate geographically for reasons other than the localization of knowledge spillovers” (Orlando, 2000: 28). The author also concludes that “... in spite of massive and continued advances in communication and transportation technologies, geography continues to play an important role” and “that technological distance attenuates spillovers is robust to various measures of geographic proximity” (Orlando, 2000: 28).

The geographic proximity of firms that are technologically distant seems not favor the desirable knowledge circulation between them, but the opposite will not hold as “the capacity of actors to absorb new knowledge requires cognitive proximity” (Boschma, 2005b: 63). According to this line of argumentation, firms need to be enough closer in technological terms to understand themselves (Boschma, 2005b). However, when they are too close they might face a lack of new ideas, losing innovation capabilities (Boschma, 2005b). One solution to this problem can be found with the cooperation with partners that have a “common knowledge base with diverse but complementary capabilities” (Boschma, 2005b: 71). In fact, according to Gentzoglanis (2001), distance

does not necessarily have a geographical dimension but it is mostly associated with *culture* and distance in knowledge. The more distant (different) firms' knowledge base is, the greater their learning potential. Accordingly, once a network is set up, interactive learning becomes possible through the establishment of procedures, which allow information channels to be shared, and codes of information to be exchanged.

Empirical findings, based on European Regional Innovation Survey (ERIS) (Koschatzky and Sternberg, 2000), highlight the importance of a combination of local, regional and trans-regional networking. Following Capello (1999), firms that are integrated into multi-layered networks, continuously improve their abilities for learning as well as their knowledge base, and concomitantly, the possibility of using new knowledge. As Capello (1996) and others put it, firms need both local networks and trans-territorial networks, because regional and global dynamics have an increasingly interdependent relationship or, in other way, using Fristch's (2003: 35) words: "cooperation tends to be a general phenomenon that is not limited to a certain type of partner".



Although, as we have shown, there have been a lot of researchers studying the inter-firms cooperation and all the aspects related with it (e.g. the nature of knowledge and proximity relevance), Koschatzky and Sternberg (2000) point that "...considering state-of-the-art research on innovation networks it is not yet clear what are the success factors of policy instruments to initiate such cooperations".

In the next chapter we briefly summarize some literature gaps related to inter-firms' cooperation, particularly R&D cooperation, which are later (Part III) empirically addressed.

Chapter 3. R&D inter firms cooperation. Uncovering some gaps

3.1. The neglecting of low tech firms in R&D cooperation

Although, as we see in the previous chapters, there is a considerable amount of empirical evidence on inter-firm collaborations within technology-based industries, there are only a few works concerned with R&D cooperation by low-tech firms, especially SMEs. Concerning evidence on R&D cooperation, Arora and Gambardella (1994) revealed the high importance of R&D collaborations for *large* US chemical and pharmaceutical companies in the biotechnology sector, whereas Colombo (1995) provided empirical evidence of a complementary relationship between inter-firm cooperative arrangements and R&D intensity for a representative sample of (*large*) international firms in the information technology industries (semi-conductor, data processing and telecommunications).

SMEs, however, are increasingly regarded as a source of dynamism in the knowledge economy, and a growing number of them are either directly or indirectly involved in research, innovation and the generation of knowledge (EC, 2005). Technology-based SMEs are seen a key component in the innovation system, facilitating the emergence of new products and markets. Also low- and medium-tech SMEs, with little or no research capability, need to reinforce their knowledge and research intensity, expand their business activities into larger markets, and internationalize their knowledge networks. Networking and cooperation has long been identified as one of the most effective ways to do this (Doloreux, 2004).

Small firms are increasingly benefiting from joint interaction with other small firms (Perrow, 1992; Bartels, 2000; Welsh et al., 2000). The importance of R&D cooperation has risen steadily as a result of growing complexity, risks and costs of innovation (Hagedoorn and Schakenraad, 1992; Dogson, 1993; Coombs et al., 1996). Therefore, for small firms, partnering with other firms through the various forms of collaborative arrangements is becoming imperative due to the insufficiency of resources and the need to achieve world-scale efficiencies (Wright and Dana, 2003).

Public support programs to promote R&D cooperation have been implemented in the last two decades in most developed countries, namely in the US, Japan and the EU

countries. The European Union's successive European Framework Programs (FPs) are a noteworthy example (Busom and Fernández-Ribas, 2004). Such programs are aimed at enhancing the performance of member countries, their organizations and citizens with regards to R&D and innovation.

Committed to bridging the gap between SMEs and R&D, the most recent FP (FP6) defines instruments to enhance SMEs' technological capacity. On the one hand, exploratory instruments provide financial aid to project submission (partners research, innovation and market research, viability studies); on the other hand, there is a "cooperative research" instrument – CRAFT – allowing consortia involving SMEs from different countries, with low or medium technological capacity and limited research abilities, to entrust research and development activities to scientific institutions (Universities or Research Institutes), while owning the results.

Thus, the analysis of such "cooperative research" instrument is likely to constitute a useful and interesting path of research for increasing our knowledge of R&D cooperation at the level of low tech SMEs.

3.2. Need for incorporating geographical, cultural and technological proximity dimensions into the analysis of R&D cooperation

As was systemized in Chapter 2, recent studies (Fristch, 2003; Doloreux, 2004; Kingsley and Malecki, 2004) gather evidence that localized external networking is less prevalent than might have been expected. In fact, in many instances, regional networks for technological development are not the most predominant ones (Doloreux, 2004). Moreover, proximity does not seem to be an important factor in shaping the structure of informal networks or the use of information (Kingsley and Malecki, 2004). This evidence concludes that the importance of proximity has in fact been overestimated. It further demonstrates that SMEs make use of a mixture of local/regional, national and even international knowledge sources, and that their ability to sustain networks at different regional scales is a key factor in competitiveness and innovativeness.

There is thus a pressing need to develop a more refined line or argument that breaks with the current view on the localized character of innovation in order to provide a deeper understanding of other similar forms of linkages which are more dispersed in space. In Bunnell and Coe's (2001: 570) words, there is a "... need for a qualitative shift away from work which focuses on particular scales as the locus for understanding

innovation, towards that which gives more credence to relationships operating between and across different scales.” Such re-focusing would lead to both theoretical enrichment and new practical applications in public policy with regard to innovation networks.

It is therefore apparent that while a large number of studies in economic geography has emphasized the spatial proximity and clustering of economic activity and its relation to the spatiality of knowledge creation in various types of connections, far less attention has been paid to the understanding of the determinants of ‘cultural’ and geographical proximity in international R&D cooperation projects.

3.3. Accounting for the quality of Regional Systems of Innovation (RSI) in cooperation relations

Fritsch (2003) and Koschatzky and Sternberg (2000) conducted relevant studies using the *European Regional Innovation Survey* (ERIS). This survey was developed between 1995 and 1997 that covers 11 European regions in order to analyze innovation linkages on a broad empirical and almost representative basis, the targets were manufacturing and service firms (the majority are SMEs) and public or semi-public research institutes (Koschatzky and Sternberg, 2000). Both studies highlight the need of empiric studies related with the interregional cooperation relations: Fritsch (2003) recognizes that not much is known about the significance of interregional differences in the propensity of enterprises to cooperate, and the relationship between cooperation behavior and the quality of the regional systems of innovation (RSI); Koschatzky and Sternberg (2000) further highlight that in “...bearing the need for further research about the success factors of regional innovation strategies in mind, it should not be overlooked ... that not all firms and other institutions might be closely linked to their region by entering intraregional innovation networks”.

The CRAFT program that involves cooperators, SMEs, and research organizations from different European regions might provide relevant information for understanding whether (and what) regional characteristics are important for R&D and innovation interregional cooperation.

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The present thesis seeks to address some of the three above-mentioned gaps by providing some results on formal international R&D networks comprising low tech SMEs and R&D institutes, using a purposely built database of CRAFTs projects. In particular, it tries to assess the effect of technological complexity, project size, and the strength of the Regional Systems of Innovation (RSI) on the cultural and geographical proximity of projects' participants.

By providing further and new evidence on R&D cooperation in relatively low tech SMEs, this study specifically seeks to answer the following research questions: 1) What is the relationship between technology and proximity in international R&D networks?; 2) What are the main determinants of cultural and geographical proximity in international R&D cooperation?; and 3) Does R&D cooperation between low tech firms involve the 'de-territorialisation of closeness'?

Before presenting estimation results based on the CRAFTs database (Chapter 6, Part III) we proceed in the next part by overviewing the existing European policies for promoting SMEs R&D capabilities, with a special focus on the case of CRAFTs projects.

**Part II – An overview of existing European policies to
promote SMEs R&D capabilities. The specific case
of CRAFTs**

Chapter 4. Critical analysis of different instruments available and their goals

4.1. Describing the European Union instruments to improve firms R&D performance

With the goal of improving and stimulating countries, organizations and citizens' performance related with R&D and innovation, essentially by the availability of financial resources, the European Union (EU) created in 1984 the *EU Framework Program for Research and Technological Development* (FP).²

This program is splitted and revised in periods of approximately four years. Each revision is numerated for better identification. The actual (2002-2006) revision is called *Framework Program VI* (FP6).

The FPs has several mechanisms, denominated *projects*, with several distinct and specific aims (e.g. improve firms R&D execution) and different addressees (universities, firms, post-graduation students, etc.). These projects can be accessed by any European organization or citizen. In the present investigation we focus essentially in the ones that target firms, particularly SMEs.³

In the context of FP6 the methods of intervention, i.e. *instruments*, specifically targeting R&D proposed by the EU might be classified in three groups (EU, 2004b):

Group 1: those that aim to generate, demonstrate and validate new knowledge through R&D (composed of *Integrated Projects* and *Specific Targeted Research Projects*) (cf. Table 3);

² In <http://europa.eu.int/comm/research/fag/index.cfm?lang=en&page=details&idfaq=3600>, accessed 2005, April 22nd.

³ Until the FP5 (1998-2002), the EU considered SMEs companies that satisfy the following criteria: less than 500 employees; no more than 1/3 of their equity can be owned by a large company (based on employees number and turnover), except if they are financial investors or venture capital companies; with a turnover inferior to 38 millions of ECU; industrial firms. After 1998 the criteria used to define a SME has changed: 1) employees number less than 250; 2) large companies equity participation inferior to 25%, except financial investors or venture capital companies, if they don't have administrative control; 3) annual turnover inferior to 40 millions of ECU and annual balance-sheet less than 27 millions of ECU; 4) any kind of private company (EC, 2001).

Table 3: Instruments aimed at generating, demonstrating and validating new knowledge through R&D

Instrument	Integrated Project (IP)	Specific Targeted Research Projects (STREP)
Purpose	Ambitious objective-driven research dealing with different issues through a “programme approach”	Objective-driven research more limited in scope than IPs and usually focused on a single issue
“Target ” audience	Industry (including SMEs), research institutes, universities, (possibly) potential end-users	Industry (including SMEs), research Institutes, universities
Activities covered by EU contribution	One or more of: research, demonstration, training, innovation, linked activities, management of the consortium	One or more of: research, demonstration, training, innovation, linked activities, management of the consortium
Funding mechanism	Cost based	Cost based
Indication of value of EU contribution⁽¹⁾	<u>€ 10 million</u> € 4 – 25 million	<u>€ 1,9 million</u> € 0,8 – 3 million
Average duration	36 – 60 months	18 – 36 months
“Optimum” size of consortium⁽²⁾	10 – 20 participants	6 – 15 participants
Flexibility	Yearly update of work plan	Fixed overall work plan
Enlargement of partnership within the initial budget	Possible through “competitive calls”	Possible
Specific characteristics	“Programme approach”, focusing on multiple issues; As a rule several components; Often multidisciplinary	“Project approach”, focusing on a single issue; As a rule one component; Often monodisciplinary

Source: EC (2004), *The Sixth Framework Program*, European Commission.

Notes: (1) Overall average of the lowest and the highest averages per project in the various thematic priorities under FP 6 so far;

(2) Not a legal requirement, but provides an indication of the number of partners the Commission services consider likely to allow the achievement of the project’s objectives.

Group 2: those composed only of the *Networks of Excellence*, an instrument aimed at the durable integration of the participants’ activities/capacities (cf. Table 4);

Table 4: Instrument aimed at the durable integration of the participants' research activities/capacities

Instrument	Network of Excellence (NoE)
Purpose	Durable integration of the participants' research activities
"Target " audience	Research institutes, universities <u>Mainly indirectly:</u> - Industry (possibly through steering committees, governing boards, scientific committees) - SMEs (possibly through take-up actions)
Activities covered by EU contribution	<u>Joint program of activities (JPA):</u> integrating activities; joint research programs; spreading of excellence and management of the consortium
Funding mechanism	<u>Calculation of the grant:</u> - Maximum grant calculated on the basis of the number of researchers; - Possibility for the participants to request a lower amount <u>Payment of the grant:</u> - Based on actual costs for implementing the JPA; - On basis of the progress towards durable integration
Indication on value of EU contribution	<u>€ 7 million</u> € 4 – 15 million
Average duration	48 – 60 months
"Optimum" size of consortium	6 – 12 participants
Flexibility	Yearly update of work plan
Enlargement of partnership within the initial budget	Possible through "competitive calls"
Specific characteristics	Institutional commitment at strategic level from the very start and for the whole duration. As a rule limited number of partners

Source: EC (2004), *The Sixth Framework Program*, European Commission.

Group 3: those targeting to support collaboration, coordination, and other activities (such as conferences and studies) that are denominated *Coordination Actions* and *Specific Support Actions* (cf. Table 5).

Table 5: Instruments aimed at supporting collaboration and coordination and other activities (such as conferences and studies)

Instrument	Coordination Action (CA)	Specific Support Action (SSA)
Purpose	Coordination, networking	Preparation of future actions, support to policy, dissemination of results
“Target ” audience	Industry (including SMEs), research institutes, universities	Industry (including SMEs), research institutes, universities
Activities covered by EU contribution	Activities intended to improve and effect the coordination of research carried out in another context that can include: programs of meetings, seminars, workshops, working groups, studies, analysis, exchanges of personnel, exchange and dissemination of good practices, setting up of information systems. Management of the consortium	Individual meetings, seminars, workshops, studies, publications, scientific awards and competitions. Management of the consortium
Funding mechanism	Cost based	Cost based. Public procurement (payment of a price following a call for tender) when provision of service to the Commission
Indication on value of EU contribution	€ 1 million € 0,5 – 1,2 million	€ 0,5 million € 0,03 – 1 million
Average duration	18 – 36 months	9 – 30 months
“Optimum” size of consortium	13 – 26 participants	1 – 15 participants
Flexibility	Fixed overall work plan	Fixed overall work plan
Enlargement of partnership within the initial budget	Possible	Possible
Specific characteristics	No funding of research activities Consistent set of activities focusing on coordination (“programme” approach)	No funding of research activities “Project” approach Possibility of one single participant

Source: The Sixth Framework Program, 2004, European Commission.

Simultaneously, this FP has other instruments denominated *specials*, with several goals: to promote human resources mobility and formation (*Marie Curie Actions*);⁴ creation

⁴ These actions provide a wide variety of possibilities to individual researchers, in different stages of their careers and also to institutions that work as hosts to those researchers. The Marie Curie Actions oblige international mobility, i.e., a researcher can’t require support to one partnership in his origin or residence country.

and improvement of research infra-structures;⁵ and to improve SMEs' capabilities, where CRAFTs are included. These last instruments have one important characteristic, i.e., participants (SMEs) must outsource the research activities to private or public specialized entities (e.g. Universities, R&D Institutes).

The FP6 great 'novelty' is the strong bet in SMEs, here considered a key element on job creation and improvement of European competitive position, which is reflected by the application of, at least, 15% of the budget (approximately 1.700 millions of euros), through the *Priority Thematic Areas*.⁶

The special instruments, exclusively to serve SMEs, absorb 430 millions of euros. One third of this amount is targeted to Collective Research Projects and the rest to CRAFTs (290 millions of euros that represent approximately 2,5% of FP6 budget (EU, 2004c)), whose characteristics we describe in detail in the next section.

4.2. The characteristics of CRAFT program and its operationalisation

The FP6 defines the designated "SMEs technological stimulation measures" by the inter-relation of SMEs and R&D actions. On one hand the *exploratory measures* provide financial support to the preparation of projects proposals (e.g. partners search, innovation and market surveys, viability studies); on the other appear one schema of *cooperative research*, where groups of SMEs (Participants), with low or medium technological capabilities, but with low or none in-house research possibilities, can subcontract the necessary R&D work to specialized entities (RTDs – Research and Technological Developers). The CRAFTs are included on this last type of measure. In Table 6 we shortly describe its characteristics, goals and how CRAFT program is organized.

⁵ These instruments are target to the promotion and development of high quality and performance infra-structures in Europe and its use in a European scale. The support is provided through the international access to the biggest research infra-structures, *networking*, collaborative research, design studies, communication networks development and new infra-structures building.

⁶ They are seven Priority Thematic Areas, targeted specifically to SMEs, of the "Integrating and Strengthening" Specific Programme, accessed through Integrated Projects (IP), Specific Targeted Research Projects (STRP) and in addition through Networks of Excellence (NoE).

Table 6: Characteristics of CRAFT projects

	Details
Goals	Support SMEs in their research and innovation needs. Promote international cooperation between SMEs and between these and other research entities.
Destinataries	SMEs
Participants number	Minimum of 3 participants (SMEs) located in at least 2 countries from the EU or associated (e.g. Switzerland). The consortium must also include at least 2 R&D executor entities (RTDs), located in at least 2 countries from the EU or associated. Other firms or final users can belong to the consortium, but must participate in the costs and can't have a dominant role during the project development. They must be independent of the other participants.
Results of research (intellectual property) owners	Participant SMEs.
Amounts involved in each project	€ 0,5 – € 2 millions.
EU funds participation	50% of the research and innovation costs; 100% consortium management costs (with a cap of 7% of the total project amount).
Projects duration	1 to 2 years.
Results dissemination	Limited.

Source: EC (2004), *The Sixth Framework Program*, European Commission, SME TechWeb, in <http://sme.cordis.lu/craft/home.cfm>, accessed March 14th, 2005.

The CRAFT program seeks to support SMEs in their R&D needs, facilitate trans-national R&D cooperation of SMEs and promote the cooperation between SMEs and the European research communities.

4.3. The CRAFT program cooperation schema specificity: a pathway for coopetition

Cooperation, as López (2004: 14) argues, "... can influence the given importance to costs and risks as innovation obstacles". Complementing, Dagnino and Padula (2002) refer that firms adopt competition or cooperation strategies with the aim of create or share value. Sometimes their interests (and goals) partially converge, being both strategies simultaneously present.

In this context, the *coopetition* concept (firms competition and cooperation hybrid behavior) emerges as essential (Dagnino and Padula, 2002). The apparent paradox can be explained by the existence of structural conditions that provoke dependence between

competitors, i.e., “...firms with competitive behavior tend to look for private benefits and such an attitude may culminate in dysfunctional outcomes. So, although this behavior helps to earn temporary rents, it makes it difficult to maintain a competitive advantage for a long time” (García and Velasco, 2002: 4). In other way, Garrafo (2002: 4) refers that “...the decision to cooperate with competitors it is generally motivated by the following reasons: (a) to access and/or exchange new technologies and complementary knowledge, (b) to access and/or stimulate new markets, (c) to influence and/or even control technological standards”.

We might advance that R&D activities and their exploration outcomes are strong motives to the development of cooptition strategies, serving R&D cooperation as a mean to increment knowledge stock to the best possible ‘price’, reflecting the ‘normal’ firms’ opportunistic logics. It seems that firms who adopt cooptition strategies have a variety of options that permit them, in one hand, simultaneously acquire knowledge and competitive advantages and, in the other hand, adapt easier to structural changes.

Analyzing the performance obtained by some European SMEs from the Biotechnology sector who use cooptition strategies, García and Velasco (2002: 8) conclude that: (i) “[the]...cooperation with direct competitors contributes positively and significantly to product lines”; (ii) “...also, collaboration with universities and research institutes that do not compete and with large companies (...) has a positive effect on product lines although to a lesser extent than direct ties with competitors”; (iii) “...alliances with direct competitors had a positive effect on technological diversity”.

The CRAFT program, which involves simultaneously *coopetitors* SMEs and R&D institutes, main goal seems to provide SMEs the possibility of profiting of the above-mentioned positive aspects.

With this kind of program, policy-makers, particularly those from the EU, seem, at least implicitly, to recognize R&D cooperation as one important way to overtake SMEs handicaps and deficiencies on these activities. So, by subsidizing the cooperation between firms and R&D organizations of several countries, and consequently regions, often very distant geographically, the EU aims at eventually contributing to diminish other distances (e.g. technological, firms performance) between SMEs, through the knowledge and experiences exchange in the technological and innovation fields.



In the next chapter we provide a detailed characterization of CRAFT projects which were considered by CORDIS ‘successful’. The goal is to get relevant information that permits the formulation of a ‘profile’ of proactive firms that simultaneously compete and cooperate in R&D, i.e., play in a *coopetition* environment.

Chapter 5. Detailed account of the CRAFT program, with an emphasis on ‘well succeeded’ projects

5.1. Gathering data on ‘well-succeeded’ CRAFTs

In this study we analyze a sub-group of CRAFTs considered ‘well succeeded’ by the EU. Details on ‘well-succeeded’ CRAFT projects are available in the site called *SMEtechweb*,⁷ from the EU, dedicated to the SMEs specific programs.

In the link ‘Success stories’ is possible to find a summary description of each project (project code, title, project purpose, process description, name and country of all the participants SMEs and RTDs, industrial sector (NACE), region and country of the promoter). Attached to each project description, there is another link to a ‘pdf’ file with more complete details, like supporting technologies, program name, project cost and EU funding.

Not all the projects included in this database belong to CRAFT program. So, removing projects from other programs (e.g., FAIR, *Collaborative*) and based on the information gathered we constructed a database with 118 CRAFT projects for analysis. These projects respect to three different FPs (3rd, 4th and 5th), involving a time span of.

Although success criterion is not explicit, some contacts with CRAFT national managers convey the information that ‘well succeeded’ projects were those which a given performer reckons as well-succeeded.⁸ Regardless the exact meaning of a ‘well succeeded’ project, there has been a trend toward a decrease in the success rate of CRAFTs (Table 7).

Table 7: Number of projects involved in the CRAFT program

	FP		
	3 rd	4 th	5 th
Submitted projects	331	1.749	1.071
Contracted projects	172	698	409
Well succeeded projects	30	65	23
Success rate	17%	9%	6%

Sources: Framework Program IV – SME Participation, 1994 – 1998, 1999, European Commission; Framework Program V – SME Participation, April 1999 – April 2001, December 2001; EU, In <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

⁷ In <http://sme.cordis.lu/home/index.cfm>, accessed in 2005, April, 30th.

⁸ The concept of ‘successful’ was given by Margarida Garrido, Portuguese contact person at Cordis.

RSI-related variables (human capital, patent propensity and employment rate) were taken from the main regional indicators published by the EC (2004).

5.2. Some descriptive results of the data

5.2.1. General description

The 118 well-succeeded CRAFTs involved 791 SME from 21 countries (18 from the European Union plus Switzerland, Norway and Brazil). In global terms, the CRAFTs under analysis were allocated around 118 million euros, which gives an average of 1 million euros per project.

From the total amount, 52% was financed by the UE, i.e., around 61 million euros. After the 3rd FP (Table 8), the rate of EU financing has passed the usual 50%, this happened in part by fact the EU began to finance the management consortia costs.

Paradoxally, when, across the considered FPs, the success rate has decreased, the level of the EU funds by project has increased. Information obtained close to the EU programs Portuguese contact point⁹ explains this fact with the change of policy by the authorities responsible for the programs management, i.e., since the FP5 the policy of projects selection becomes more restrictive. The EU prefers to finance in a lesser extent but bigger projects, aiming to have a better control of them and consequently higher success rates.

Table 8: Number of projects involved in the CRAFT program

	FP		
	3 rd	4 th	5 th
Total amount of projects	21.747.000	62.023.212	34.657.795
Total amount of EU funds	10.870.500	31.410.943	18.872.753
Project average amount	724.900	954.203	1.506.861
Average amount of EU funds	362.350	483.245	820.554
Average rate of EU funds	50%	51%	54%

Source: Authors' calculation based on EU information, In <http://sme.cordis.lu/craft/home.cfm>, accessed on 30th April 2005.

⁹ Through a phone call, in 2005, 29th of June, to the responsible person, Mrs. Cristina Guedes (Direcção Geral da Empresa).

5.2.2. Classification of ‘well-succeeded’ CRAFTs by activity area

The original data related to the activity sectors (NACEs) were very diverse, encompassing 32 different industries. So, we aggregated them into 18 Standard Industrial Classification (SICs), to better workability and interpretation.¹⁰

The main activity areas of well-succeeded CRAFTs (Table 9) are: Machinery and Equipment, Agriculture, Building and Metallic products. High technology activities, such as Telecommunications, Computing and R&D have a smaller contribution. This last characteristic may result from the fact that the program aims at enhancing cooperative research by groups of SMEs with low or medium technological capabilities, with a restricted capacity for proper research, and encourages SMEs consortia to entrust research activities to a third party (e.g. University or R&D institutes).

Table 9: Industry distribution of well-succeeded CRAFTs

Activity	N° of projects	Percentage
Machinery	13	11.0
Agriculture	10	8.5
Building	10	8.5
Metallic products	10	8.5
Electric products	9	7.6
Chemicals	8	6.8
Health	8	6.8
Textiles	8	6.8
Wood industries	7	5.9
Other manufacturing industries	6	5.1
Food and beverages	5	4.2
Computing and R&D	5	4.2
Precision tools	5	4.2
Other services	5	4.2
Transports	5	4.2
Telecommunications	2	1.7
Non metallic products	1	0.8
Retail	1	0.8
Total	118	100.0

Source: Authors' computations based on data from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

¹⁰ In Appendix 3, Table 32, we describe the transformation from NACEs into SICs.

5.2.3. Classification of ‘well-succeeded’ CRAFTs using Pavitt taxonomy

We additionally aggregate SICs into smaller number of industries using the taxonomy proposed by Pavitt (1984).¹¹ Pavitt (1984) identifies differences in the importance of different sources of innovation according to which broad sector the individual firm belongs. This author, taking in consideration the specificity of each activity sector, innovations nature and their impact, knowledge sources, inputs, firms size and their activity lines, defined one way to characterize firms by their technological capacity and, mainly, their motivation.

This taxonomy group firms, using as base the activity sectors they belong, classifying them into three main segments:

- 1) *Supplier dominated* (SD) – firms from traditional production sectors (agriculture, construction and several professional services, financiers and commercial). Generally they are small and their internal R&D capacities are weak. Their technological choices are driven by the will of reducing cost. Their products or processes have small technological contributions from their own. The majority of innovations come from their equipment or materials suppliers and, sometimes, from big customers or R&D institutes.
- 2) *Production intensive*, which are further divided into two types
 - (i) *Scale Intensive* (SI) – firms that operate in scale economies sectors, like food products, metallurgic, motorized vehicles, concrete, glass. Eventually they can specify or design new equipment with the aim of improving productivity;
 - (ii) *Specialized Suppliers* (SS) – relatively small and specialized firms that supply equipment to the *scale intensive* ones, with whom maintain close and complementary relationships.
- 3) *Science based* (SB) – firms from the chemical and electronic sectors. The main sources of technology are the sectors’ R&D activities, based in the fast development of scientific concepts from the universities and others.

¹¹ See details of this taxonomy in Table 31 (Appendix 2) and from the aggregation procedure in Table 32, in Appendix 3.

Even though the taxonomy was devised at the level of the firm, it has implications at the level of the industry, as we would expect the broad sectoral regularities of firms to be reflected in the aggregate behavior of the sector. Thus, given the above description of the taxonomy, one would expect internal R&D to be most important for gaining market shares in science-based sectors, while upstream and downstream linkages should be expected to be more important in the case of specialized suppliers. For scale intensive sectors, investment and inter-sectoral linkages - but also to some extent R&D - should be of importance, while supplier dominated sectors should to some extent be expected to be determined by investment, upstream linkages and by low unit labor costs. But as we are dealing with sectors of traditional manufacturing in this case, more traditional factors (resource endowments) might be particularly important for these sectors.

The Pavitt taxonomy has been criticized on a number of points, including a set of criticisms relating to the fact the sectoral boundaries are not always straightforward (Laursen and Meliciani, 1999). That is, firms (and sectors) cannot always easily be uniquely defined as one of the four Pavitt type firms. Some firms (and sectors) may have such attributes, so that they can be said affiliated to more than one of the Pavitt-type sectors. It should be stressed however, that while the Pavitt taxonomy has held up reasonably well in subsequent empirical tests (Cesaratto and Mangano, 1992; Arundel et al., 1995), it inevitable simplifies.

So, using the projects economic activity classification described before (Table 9) and also the support technologies related to each one, we obtained an approximated distribution of projects (Table 10).

Table 10: Classification of ‘well succeeded’ CRAFTs according to the Pavitt’s taxonomy

	← High-tech		Low-tech →	
	<i>Science based</i>	<i>Production Intensive</i>		<i>Supplier dominated</i>
		<i>Specialized supplier</i>	<i>Scale intensive</i>	
Projects rate (%)	18,6	16,9	30,5	33,9

Source: Authors’ computations based on data from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

According to the Pavitt taxonomy, around 64.4% of projects belong to *supplier dominated* or *scale intensive* sectors. *Science based* sectors encompass approximately 20% of total projects.

5.2.4. Classification of ‘well-succeeded’ CRAFTs using OECD taxonomy (*high-tech; medium tech; low tech*)

The literature concerning innovation-related classifications of industries is surprisingly scant and tends to be dominated by the Pavitt’s (1984) taxonomy and the OECD’s popular High-tech/Low-tech dichotomy (Marceau and Manley, 1999). Some authors (e.g., Pol et al, 2001: 1) consider the use of Pavitt’s taxonomy “... understandable because his classificatory scheme has merit, but the use of the High-tech/Low-tech dichotomy is unfortunate because it has only limited scope”.

In the mid-1980s the OECD invented a classificatory scheme based on R&D intensity: high-technology, medium-technology, and low-technology industries. Table 11 shows the latest OECD classification.¹² This table is reminiscent of the *Tableau Economique* in that it is a primitive map of an extraordinarily vast and complex collection of facts.

Table 11: Technology table –OECD classification of industries by level of technology

	OTI	Direct R&D intensity	
		<i>R&D/Production</i>	<i>R&D/value added</i>
<i>High tech industries</i>			
Aircraft	17.3	15.0	36.3
Office and computing machinery	14.4	11.5	30.5
Pharmaceutical products	11.4	10.5	21.6
Radio, TV and comm. equip.	9.4	8.0	18.7
<i>Medium-high tech industries</i>			
Professional goods	6.6	5.1	11.2
Motor vehicles	4.4	3.4	13.7
Electrical machinery	4.0	2.8	7.6
Chemicals	3.8	3.2	9.0
Other transport equipment	3.0	1.6	4.0
Non-electrical machinery	2.6	1.7	4.6

(...)

¹² See details of the aggregation procedure in Table 32 in Appendix 3.

(...)

	OTI	Direct R&D intensity		
		R&D/Production	R&D/value added	
<i>Medium-low tech industries</i>				
Rubber and plastic products		2.5	1.1	3.0
Shipbuilding and repairing		2.2	0.7	2.1
Other manufacturing		1.8	0.6	1.5
Non-ferrous metals		1.6	0.9	3.5
Non-metallic mineral products		1.4	0.9	2.2
Metal products		1.4	0.6	1.4
Petroleum products*		1.3	1.0	8.4
Iron and steel		1.1	0.6	2.5
<i>Low tech industries</i>				
Paper and paper products		0.9	0.3	0.8
Textiles, apparel and leather		0.8	0.2	0.7
Food, beverages and tobacco		0.7	0.3	1.1
Wood products and furniture		0.7	0.2	0.5

* Includes refineries.

Legend: OTI = Direct R&D intensity (measured by R&D/production) + Indirect R&D intensity

Source: OECD (1999), p.106

Note: The *Tableau Technologique* refers to the year 1990.

In our work, to clarify and simplify the analysis we use only three groups: *High Technology*, *Medium Technology* e *Low Technology*.

The result obtained (Table 12) is similar to the one obtained with the Pavitt's taxonomy, although with more disparity in respect to the projects that belong to high technology sectors – the rate is smaller (11% comparatively with the 18,5% referred in Pavitt's taxonomy) - and the low technology – the value obtained is higher (50,8% to 33,9%).

Although there are differences in the percentages obtained with the two taxonomies, both point to the fact that the higher percentage of projects are from sectors considered low or medium technology, as we expected give CRAFTs' characteristics.

Table 12: ‘Well succeeded’ CRAFTs classification following OECD taxonomy

	Classificação		
	<i>High technology</i>	<i>Medium technology</i>	<i>Low technology</i>
Percentage	11,0%	38,1%	50,8%

Source: Author's computations based on data from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

5.2.5. Country and regional distribution of the projects

If we analyze the country of origin of the SMEs participating in well-succeeded CRAFTs (Figure 1), we observe that 73% of participating SMEs belong to Germany, France Spain, the United Kingdom, The Netherlands and Italy.

Spanish companies (103) are concentrated in 36 projects. That is, when a Spanish SME participates in a project it pushes two additional Spanish companies. Although on a smaller scale than Spain, there is also a relative intensity of internal cooperation between Portuguese partners, as each Portuguese partner seems to engage two other partners of the same nationality. The two countries with a higher number of participating companies, Germany and France, are also those that participate in a larger number of projects: 64 and 53, respectively.

Generally, cooperation between research institutions of the same country is weaker than between same country SMEs. Austria is an exception, with 3 Austrian institutions per project.

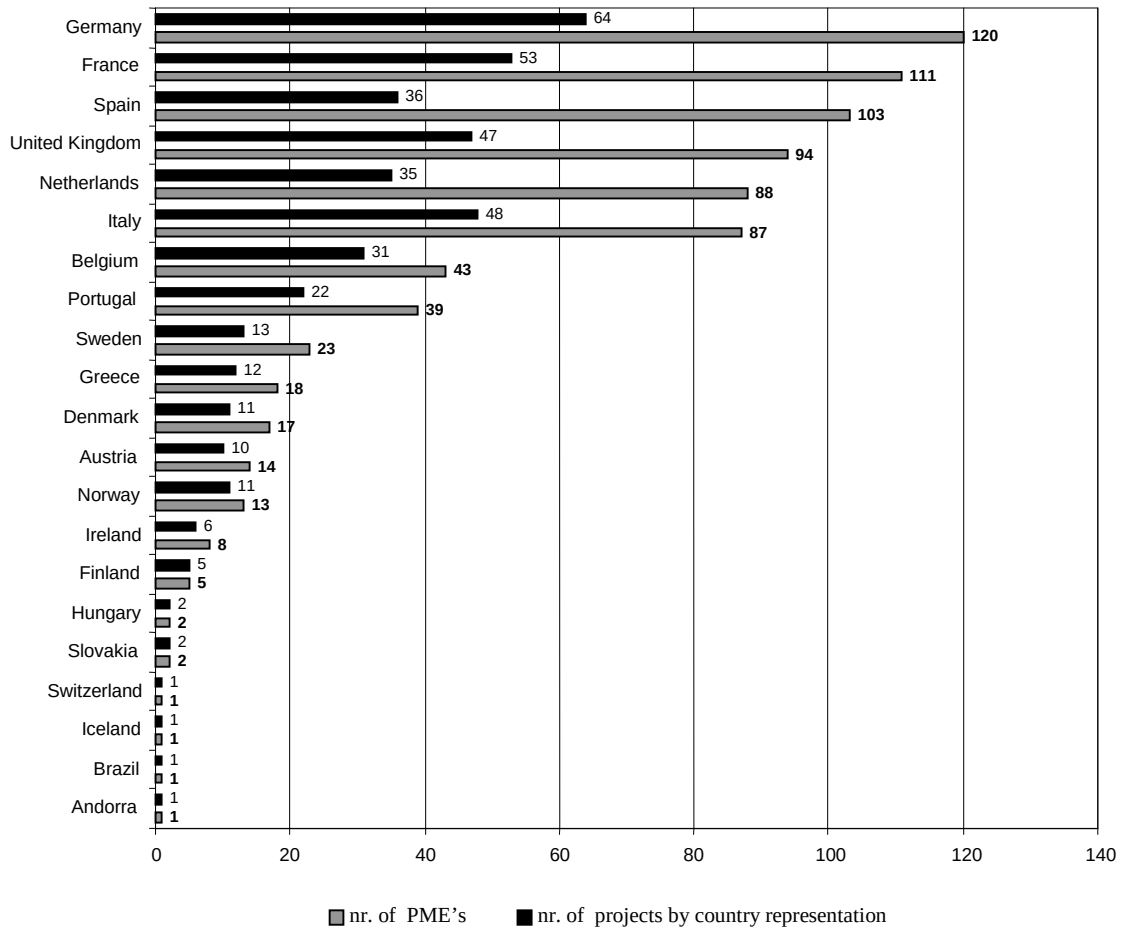


Figure 1: Number of SMEs performers by country

Source: Authors' computations based on data from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

The 'well-succeeded' CRAFT database identifies the main region where each Project is developed. With few exceptions it is the region where the prime SMEs contractor is located. Although it was not possible to identify the region of origin for all the participating SMEs, we analyzed the regional origin of the first promoter in order to identify the regions with a higher 'promoting' ability.

The regions with a higher promoting capacity, involved in well succeeded CRAFTs (Figure 2) are *Noroeste* (Spain) and *Sud-Ouest* (France) both with 7 projects each, *Vlaams Gewest* (Belgium), *Baden-Württemberg* (Germany) and *West-Nederland* (Netherlands), with 6 projects each. Although country sizes are very different, the United Kingdom and France are the countries with more promoting regions, 8 and 7, respectively.

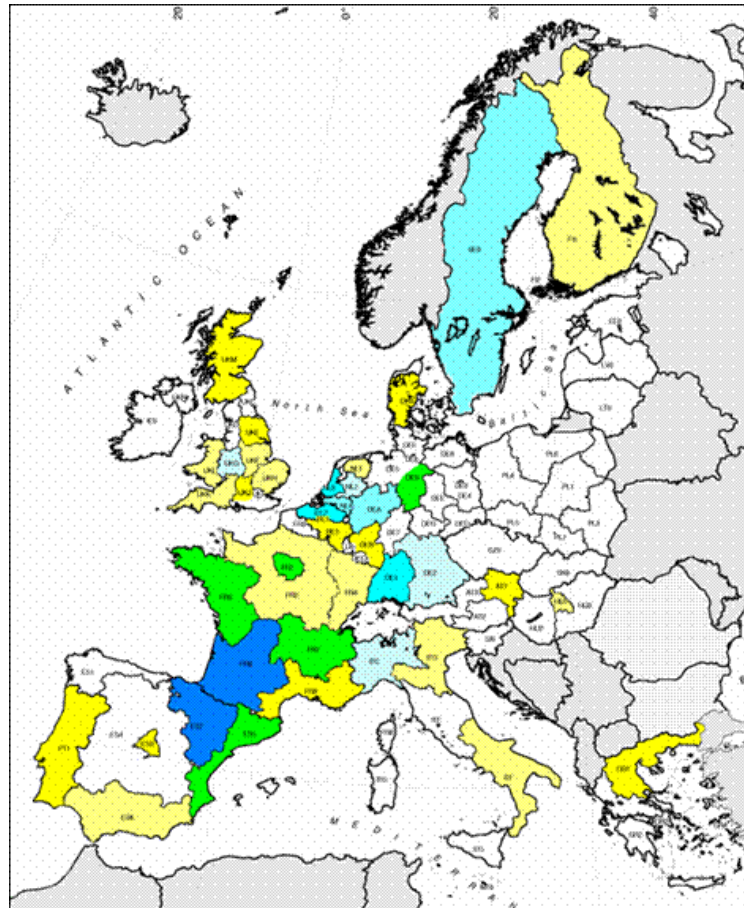


Figure 2: Regional distribution (NUTS I) of well succeeded CRAFTs

Source: Authors' computations based on data from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.
The map was drawn from http://europa.eu.int/comm/eurostat/ramon/nuts/home_regions_en.html, accessed in July 2005.



A well-succeeded CRAFT (Table 13) involves, on average, about 10 participating entities, generally from Germany and France, in supplier dominated and low technology sectors. In well-succeeded projects funding allocated to SMEs attains 49.8%. The average cost per SME of a standard project is 241 thousand euros, and the average yield of participating research institutions is 400 thousand euros.

Table 13: Main characteristics of well-succeeded CRAFT projects

	Description	Unity	Minimum	Maximum	Average
General characteristics	No. of technological areas		1,0	10,0	2,7
	EU funding	€	39,1	76,3	50,2
	SMEs participation	€	23,7	60,9	49,8
	Pavitt's taxonomy			<i>Scale intensive</i>	
	OECD's taxonomy			<i>Low technology</i>	
	Average cost per SME	€	0,0	5.190.000,0	241.747,3
	Average yield per RTD	€	0,0	1.633.000,0	400.718,4
	No of represented countries		4,0	26,0	9,6
SMEs share (%)	Austria	%	0,0	57,1	1,9
	Germany	%	0,0	75,0	16,8
	Spain	%	0,0	85,7	11,1
	France	%	0,0	66,7	14,2
	Italy	%	0,0	80,0	11,5
	United Kingdom	%	0,0	66,7	10,8
	Belgium	%	0,0	100,0	5,9
	Denmark	%	0,0	60,0	2,2
	Greece	%	0,0	25,0	1,1
	Ireland	%	0,0	37,5	0,7
	The Netherlands	%	0,0	100,0	11,0
	Norway	%	0,0	50,0	2,0
	Portugal	%	0,0	64,3	4,4
	Sweden	%	0,0	75,0	3,6
	Austria	%	0,0	100,0	1,2
RTDs share (%)	Germany	%	0,0	100,0	20,3
	Spain	%	0,0	80,0	8,5
	France	%	0,0	100,0	18,7
	Italy	%	0,0	100,0	6,5
	United Kingdom	%	0,0	100,0	13,2
	Belgium	%	0,0	100,0	3,8
	Denmark	%	0,0	50,0	2,4
	Greece	%	0,0	50,0	1,0
	Ireland	%	0,0	50,0	1,0
	The Netherlands	%	0,0	100,0	11,3
	Norway	%	0,0	50,0	1,8
	Portugal	%	0,0	75,0	3,0
	Sweden	%	0,0	80,0	3,5

Source: Authors' computations based on data from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

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The database constructed is likely to constitute a solid point of departure for further analysis undertaken in Part (III). This database includes CRAFTs projects which involve SMEs (the majority, as we have shown, are low or medium technology) that cooperate in R&D. The participants (SMEs) may or may not be localized in the same

country or region; they may belong to similar or different technological domains or possess similar or different capabilities, sharing similar or different cultures..

With this database we aim to give our modest contribution in order to fill some of the literature gaps put forward in Chapter 3, namely by assessing the determinants of geographical and cultural proximities and evaluate the relevance of Regional Systems of Innovation (RSI) in low-tech, international R&D cooperation.

**Part III – An empirical analysis on the determinants of
geographical and cultural proximity in
international R&D cooperative projects. Assessing
the relevance of Regional Systems of Innovation**

Chapter 6. Estimating the determinants of geographical and cultural proximity. The relevance of the quality of Regional Systems of Innovation

6.1. Initial considerations

Using the database described in Chapter 5, with 118 CRAFT projects considered successful by the EU, from the 3rd to 5th FPs, we aim here to assess whether cultural proximity or geographical distance associated with each successful CRAFTs are determined by factors related to RSI strength, namely human capital intensity, innovation related performance, and labor market performance.

6.2. RSI conceptualization and the relevance of its quality to ‘boost’ international cooperation

The concept of Regional Systems of Innovation (RSI) is somehow related to that of National Innovation Systems, which was first developed to describe the process of innovation in developed economies (Lundvall, 1992). The approach has shifted from solely a national perspective to one including regional or local systems. This focus on spatial aspects has two major advantages: it recognizes that innovation is a social process and a geographic process. In a seminal book ‘Regional Innovation Systems - The Role of Governances’, Braczyk et al (1998) provide a profound analysis of the Regional Innovation System or RSI.¹³ In the introductory part of that book, Cooke (1998: 24) acknowledges that “...the origin of the concept lies in two main bodies of theory and research”: regional science and innovation as national process.

The first main body is related to the exploration of the “...extent to which innovation processes at regional level could be defined as systemic” (Cooke, 1998: 24); the other reports to the “...convergence or divergence among national innovation arrangements, given globalization and supranational innovation programmes” (Cooke, 1998: 24) and particularly to the contribution of national systems of innovation literature that correct “...the perceived wisdom about innovation processes by showing them to be interactive,

¹³ Some authors, namely Cooke (1998), prefer the wording ‘Regional Innovation Systems’ (RIS) instead of ‘Regional Systems of Innovation’ (RSI) that is more frequently used in the present thesis. Both wordings, however, mean the same thing, being its choice just a matter of personal preference.

not linear, and introducing the important concept of ‘institutional learning’ into this more systemic analysis of innovation” (Cooke, 1998: 24).

A closer analysis of Cooke’s statements, particularly focusing on some keywords related with RSI such as *systemic*, *interactive*, *not linear*, *programmes*, ‘*institutional learning*’, permits at identifying some characteristics that are important to define a region as innovative in a regular base. Indeed, some factors such as governmental (or regional) policies, knowledge creation, absorption or circulation, are clearly identified by the literature as important to the innovation process, but the presence of these factors in one region do not make this later, per se, innovative. It is the *systemic* use of all those sources, by a large base of actors in the region, through an *interactive* process that enable their conversion into innovative outputs in a regular base.

This ‘capacities’ drives us to into the concept of ‘institutional learning’ that, as Cooke (1998: 15) describes, has the following characteristics: 1) “...*reflexivity*: the capacity of self-monitor, reflect on the core values of the organization and operate from the standpoint of all actors involved”; 2) “...*transdisciplinarity*: the ability to overcome the ‘not invented here’ syndrome so that innovation arises from a particular application context, rather than a specific spot on the disciplinary map”; 3) “...*heterogeneity*: the capacity to bring multiple skills and experiences to bear on a problem. This involves multiple sites, linkages and differentiation at sites of knowledge production”.

Summarizing, the RSI are regions that have the ability of enhance this ‘institutional learning’ with the aim of getting economic advantages, through innovation. Nevertheless, Cooke (1998) points two weaknesses of RSI: 1) it is related with the intrinsic nature of this regions, i.e., the mutual dependence (strategic expectations) between entrepreneurs and the RSI, they belong, culture, tend to converge to a kind of ‘unanimous’ behavior, this absence of diverging voices “...may delay *strategic* creativity at critical points when a rapid response to the need for innovation is required” (Cooke, 1998: 9); and 2) a contraction in demand can change the region ‘balance’ and the excess of “...competition may become cut-throat and destructive” (Cooke, 1998: 10).

The first point seems to emphasize the relevance of firms belonging to one RSI, of ‘socialize’ with others from other regions, with different (distant) cultures, with the aim of feed their own region with different ideas (one source of innovation process).

To overcome those ‘fragile’ points Varaldo and Ferruci (1996) consider that “...the future of district firms relies more and more on their capacity to make links to non-district firms displaying strategic competitive advantage in networks of global firms”. This statement, as we previously pointed (Chapter 2), is in line with the thought of some researchers (e.g., Capello, 1996, 1999; Koschatzky and Sternberg, 2000; Britton, 2003; Fristch’s, 2003; Doloreux, 2003, 2004) who highlighted the importance of combining local, regional and trans-regional networking, or what Cooke (1998) calls a “network of networks”.

Thus, regions in order to successfully compete in a globalization logic, face the need “...of creating an innovative local environment, wherein innovative strength must define itself in a global context” (Braczyk and Heindenreich, 1998: 415), or, in other words, their quality (or strength) come from their actors’ ability to cooperate locally and internationally.

6.3. Construction of RSI-strength proxy

As we already mentioned in Chapter 5, each project involves several participants from different countries and regions. Although in optimal terms we should device an synthetic indicator of RSI quality, given our time and resources constraints, we opted for considering in the RSI characterization only the region of the first performer, who tends to be the entity that pushed and commanded the project.

Thus, for each project we identify the NUTS level 1 (Figure 2) where the 1st performer is located. Then we associate the NUTS level 1 corresponding values of several key variables taking from the literature as important items associated to RSI quality and performance.

Statistical measurements on RSI are being developed in five key areas: innovation systems; innovation; government S&T activities; industry; and human resources, including employment and higher education (Anderson, 1998).

A key requirement of any regional economy and technological system is the availability of labor, and particularly staff with the necessary skills and quality (Nam et al., 1990; Wiig and Wood, 1995). Thus, in order to pick up these aspects, we collected from the main regional indicators, published by the European Commission in the Third Report on Economic and Social Cohesion (EC, 2004), data on the employment rate (employed

population aged 15-64 as percentage of total 15-64 population, 2002) (*ER*), and the number of 15-64 aged population who attained higher education level as a percentage of that total group age (2002) (*HC*).

Moreover, patents reflect part of a region's inventive activity. Patents also show the region's capacity to exploit knowledge and translate it into potential economic gains. In this context, indicators based on patent statistics are widely used to assess the inventive performance of countries or regions (Acosta and Coronado, 2003; EU, 2005). The corresponding indicator for this variables is—the European Patents Office (EPO) application per million inhabitants, average 1999-2001 (*PAT*), gathered also from EC (2004). .

6.4. Proxy construction for ‘cultural’ proximity and geographical distance using CRAFTs

In the construction of the proxy for ‘cultural’ proximity, *promoter identity index*, we adopt the following methodology: considering the nationality of the first SME performer (1st contractor), we compute, for each project, the relative frequency of other SMEs and RTDs that belong to the same country of the 1st performer. Thus, we assume that when there are no participants of the same nationality as the 1st performer in a project, ‘cultural’ proximity is minimum (0). Alternatively, the maximum value that this variable could take is 100%, which corresponds to the case where all project participants belong to the same country of origin as the 1st performer.

With regard to the geographical distance proxy, we calculate, for each project, the average distance (in kilometers) between each SME participant and the 1st performer. As information on the location of each project participant is not available, distance was computed with reference to each country's capital.

6.5. Model specification and variable description

We propose two main model specifications. In both specifications, the dependent variable is explained by two sets of independent variables: variables related to project characteristics and RSI strength. The two model specifications proposed differ in the variables related to project characteristics. In particular, the restricted model considers only ‘core’ project characteristics, namely technological diversity, industry code (according to the Pavitt and OECD taxonomies), SMEs average project cost and RTDs

average project yield. The alternative specification (enlarged model), besides ‘core’ project variables, also includes country specific variables. The latter reflect, for each project, the countries’ weight in total SMEs and RTDs participation.

$$y_i^1 = \alpha^1 + \beta_1^1 TD_i + \beta_2^1 IC_i + \beta_3^1 SMEC_i + \beta_4^1 RTDY_i + \lambda_1^1 PAT_i + \lambda_2^1 ER_i + \lambda_3^1 HC_i + e_i^1 \quad (1)$$

$$y_i^2 = \alpha^2 + \beta_1^2 TD_i + \beta_2^2 IC_i + \beta_3^2 SMEC_i + \beta_4^2 RTDY_i + \pi CSW_i + \lambda_1^2 PAT_i + \lambda_2^2 ER_i + \lambda_3^2 HC_i + e_i^2 \quad (2)$$

Where

i: is a given CRAFT project;

y: is the dependent variable – promoter identity index (proxy for cultural proximity, y_1) or average promoter-participant distance (proxy for geographical distance, y_2);

TD: project technological diversity (natural log of the number of support technologies in a given project);

IC: project industry code (defined by the Pavitt or the OECD taxonomies);

SMEC: project cost per SME participant;

RTDY: project yield per RTD participant;

PAT: patents application per million inhabitants (1999-2001 average);

ER: employment rate (2002);

HC: post-secondary education rate (2002);

CSW: country specific weight of SMEs or RTD project participants;

α ; β ; λ and π : are the independent variables coefficient estimators;

e: is the random white noise error term.

The detailed description of each project supplied by CORDIS contains information on the project’s number of support technologies (different technological areas associated with the project). Therefore, we take the natural log of the number of support technologies in a given project as a proxy for the project’s technological diversity.

The project industry NACE code was transformed into a smaller number of industries, using the Pavitt (1984) and the OECD (1992) taxonomies (see Sections 5.2.2 and 5.2.3.). The first one aggregates industries into four main groups, by increasing order of technological complexity and nature of knowledge source – supplier dominated, scale

intensive, specialized suppliers and science based. The OECD taxonomy groups industries into three main sets according to R&D intensity – low, medium and high technology industries. *IC* assumes the values 1 to 4 in the case of the Pavitt taxonomy and 1 to 3 in the other case.

The *SMEC* variable is defined as a ratio between the project's total cost, expressed in million euros, and the number of SME participants. Similarly, the *RTDY* represents the ratio between the project's total yield, expressed in million euros, and the number of RTD participants.

The country specific weight of each project's SME (RTD) participants is computed by taking the total number of SMEs (RTDs) belonging to a particular country as a percentage of the total SME (RTD) participants. For estimation purposes, and as depicted in Figure 1, we consider only the six main countries.

The Table 14 presents the main descriptive statistics and the correlation matrix of the variables under analysis. On average, 1/3 of project participants have the same nationality as the 1st promoter. 'Cultural' proximity (promoter identity index) is significantly and negatively related to technological diversity, the SME average cost, RTD average yield and human capital variable. It is significantly and positively related to the employment rate of the 1st project promoter's region. The average promoter-participant distance (proxy for geographical distance) is only significantly (and negatively) related to the SMEs cost and employment rate.

Table 14: Descriptive statistics and correlation matrix

	Mean	Min	Max	SD		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Promoter identity index	0,33	0	0,81	0,184	Pearson	1	-0,152	-0,287	-0,133	-0,130	-0,201	-0,224	-0,056	0,206	-0,194
					Sign		0,106	0,002	0,158	0,169	0,032	0,017	0,552	0,028	0,039
(2) Promoter-participants average distance	6,31	0	7,88	1,053	Pearson		1,000	0,077	-0,004	-0,026	-0,720	0,041	-0,009	-0,198	-0,144
					Sign			0,416	0,970	0,781	0,000	0,666	0,923	0,034	0,126
(3) Technology diversity	0,90	0	2,30	0,426	Pearson			1,000	-0,178	-0,115	0,064	0,224	0,033	0,053	0,237
					Sign				0,058	0,224	0,497	0,017	0,726	0,576	0,011
(4) Pavitt code	2,20	1	4,00	1,106	Pearson				1,000	0,746	-0,029	-0,008	0,021	0,039	0,176
					Sign					0,000	0,759	0,931	0,820	0,680	0,061
(5) OCDE code	1,60	1	3,00	0,681	Pearson					1,000	0,023	0,058	0,013	0,104	0,148
					Sign						0,806	0,539	0,895	0,272	0,115
(6) SMEs average cost (million €)	0,24	0	5,19	0,537	Pearson						1,000	0,123	-0,016	0,010	0,113
					Sign							0,192	0,869	0,912	0,230
(7) RTD average yield (million €)	0,40	0	1,63	0,262	Pearson							1,000	0,066	-0,063	-0,060
					Sign								0,483	0,507	0,524
(8) Patents (million inhabitants)	182,01	4,3	536,70	157,930	Pearson								1,000	0,442	0,085
					Sign									0,000	0,369
(9) Employment rate (%)	66,51	44,4	77,00	6,199	Pearson									1,000	0,206
					Sign										0,028
(10) Human capital (% post sec. education)	23,99	7,2	37,30	6,325	Pearson										1,000
					Sign										

Note: Shadowed values are statistically significant (positively or negatively) at 1%-5%-10%.

Based on the data and the constructed proxies for the relevant variables, we aim at testing three main hypotheses.

Hypothesis 1: Technologically more complex projects are more likely to involve ‘culturally’ and geographically more distant partners.

Projects encompassing a wider range of support technologies and belonging to intensive high technology industries would tend to require partners with more diverse and complementary technological capabilities, that is, from different regional systems of innovation. Thus, we would expect that $\beta_1^1 < 0$; $\beta_1^2 > 0$ and $\beta_2^1 < 0$; $\beta_2^2 > 0$.

Hypothesis 2: Larger international cooperative projects involve more culturally dissimilar and geographically distant partners.

We might expect that the higher the (average) yield, that is, the size of the project, the more internationalized the project is, and therefore, dissimilarity among the nationalities involved would be more likely and the geographical distance would be greater. That is, we would expect that $\beta_3^1 < 0$; $\beta_3^2 > 0$.

Hypothesis 3: International cooperation projects involving promoters from innovation-led regions are culturally and geographically more distant.

The promoters of international cooperative projects who come from less endowed and innovative-led regions tend to concentrate on more ‘national’, culturally and geographically close partners. In this line, if this hypothesis is corroborated, we would expect $\lambda_1^1, \lambda_2^1, \lambda_3^1 < 0$ and $\lambda_1^2, \lambda_2^2, \lambda_3^2 > 0$.

6.6. Estimation results

The model was estimated using *OLS*. The number of projects included as valid observation is 114, as no regional data was available for one of the countries (Norway), and for the remaining three projects some variables are missing.

Estimation results for the ‘cultural’ proximity proxy are presented in Table 15 and for the geographical distance proxy in Table 16.

In general, all the estimated models present a reasonable fit. In fact, when considering jointly the adjusted *R square*, *F-statistics*, and the *Durbin Watson*, we have sufficient statistical evidence that the models reflect reality quite appropriately.

Table 15: Estimation results (dependent variable: promoter identity index or ‘cultural’ proximity)

			Model I		Model II		Model III		Model IV		Model V		Model VI	
Variable description		Mean	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value
Project characteristics	Technology diversity (in number of support technologies)	0,899	-0,111	0,006	-0.106	0.008	-0.111	0.009	-0.110	0.009	-0.106	0.012	-0.105	0.012
	Pavitt code (1: supplier dominated ... 4: science based industry)	2,193	-0,028	0,057			-0.029	0.049	0.026	0.080				
	OECD code (1: low ... 3: high technology industry)	1,596			-0.043	0.073					-0.042	0.073	-0.038	0.116
	SMEs average cost (million €)	0,241	-0.055	0.056	-0.052	0.069	-0.034	0.246	-0.049	0.092	-0.031	0.289	-0.046	0.111
	RTD average yield (million €)	0,400	-0.087	0.158	-0.081	0.188	-0.056	0.362	-0.058	0.366	-0.055	0.377	-0.057	0.375
	SMEs	France					0.002	0.027			0.002	0.026		
		Germany					0.001	0.479			0.001	0.386		
		Italy					0.0003	0.767			0.000	0.836		
		Netherlands					-0.0003	0.795			0.000	0.973		
		Spain					0.002	0.014			0.002	0.014		
		United Kingdom					0.001	0.429			0.001	0.329		
		France							0.0005	0.498			0.001	0.428
	RTDs	Germany							0.0004	0.488			0.001	0.417
		Italy							0.0000	0.994			0.000	0.957
		Netherlands							-0.0006	0.471			0.000	0.599
		Spain							0.0021	0.059			0.002	0.052
		United Kingdom							0.0001	0.871			0.000	0.666
	Patents (per million inhabitants)	178,7	-0.0002	0.073	-0.0002	0.061	-0.0002	0.139	-0.0002	0.135	-0.0002	0.113	-0.0002	0.128
	Employment rate	66,6	0.010	0.001	0.010	0.001	0.015	0.000	0.013	0.000	0.015	0.000	0.013	0.000
	Human capital (post secondary education)	24,1	-0.004	0.115	-0.005	0.085	-0.006	0.048	-0.005	0.086	-0.006	0.031	-0.005	0.058
Constant			0,049	0.788	0.027	0.881	-0.386	0.122	-0.212	0.371	-0.376	0.133	-0.0229	0.333
N° observations			114		114		114		114		114		114	
Adjusted R square			0.212		0.209		0.245		0.216		0.240		0.211	
F-statistic			5.350	0,000	5.275	0.000	3.824	0.000	3.388	0.000	3.748	0.000	3.322	0.000
D-Watson			2.011		2.056		2.171		2.098		2.212		2.149	

Note: Shadowed values are statistically significant (positively or negatively) at 1%-5%-10%.

Table 16: Estimation results (dependent variable: average promoter-participant distance or ‘geographical distance’)

Variable description		Mean	Model I		Model II		Model III		Model IV		Model V		Model VI	
			Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value	Coeff. estimate	p-value
Project characteristics	Technology diversity (in number of support technologies)	0,899	0.330	0.060	0.336	0.053	0.331	0.040	0.314	0.079	0.374	0.019	0.336	0.058
	Pavitt code (1:supplier dominated ... 4: science based industry)	2,193	0.015	0.818			-0.005	0.925	0.005	0.938				
	Oecd code (1: low ...3: high technology industry)	1,596			0.049	0.633					0.106	0.231	0.077	0.451
	SMEs average cost (million €)	0,241	-1.423	0.000	1.424	0.000	-1.428	0.000	-1.455	0.000	-1.429	0.000	-1.455	0.000
	RTD average yield (million €)	0,400	0.327	0.222	0.316	0.240	0.428	0.068	0.507	0.065	0.396	0.090	0.488	0.075
	SMEs						-0.012	0.002			-0.012	0.001		
							-0.007	0.058			-0.007	0.056		
							0.002	0.578			0.002	0.638		
							-0.021	0.000			-0.022	0.000		
							-0.002	0.615			-0.002	0.628		
							-0.008	0.041			-0.009	0.028		
									-0.006	0.082			-0.006	0.079
									-0.001	0.615			-0.001	0.648
									0.001	0.771			0.001	0.783
									-0.009	0.010			-0.009	0.009
	RTDs								-0.002	0.722			-0.002	0.733
									-0.005	0.105			-0.006	0.089
RSI strength	Patents (per million inhabitants)	178,7	0.0005	0.336	0.0005	0.325	0.001	0.188	0.0002	0.783	0.001	0.174	0.0001	0.788
	Employment rate	66,6	-0.036	0.004	-0.037	0.003	-0.013	0.341	-0.032	0.032	-0.014	0.299	-0.033	0.029
	Human capital (post secondary education)	24,1	-0.009	0.445	-0.009	0.422	-0.001	0.932	-0.0001	0.991	-0.003	0.767	-0.001	0.912
Constant			8.725	0.000	8.722	0.000	7.560	0.000	8.586	0.000	7.495	0.000	8.531	0.000
N° observations			114		114		114		114		114		114	
Adjusted R square			0.560		0.561		0.681		0.577		0.685		0.580	
F-statistic			21.528	0.000	21.589	0.000	19.542	0.000	12.875	0.000	19.935	0.000	12.992	0.000
D-Watson			1.873		1.864		1.996		2.058		2.007		2.061	

Note: Shadowed values are statistically significant (positively or negatively) at 1%-5%-10%.

With regard to the factors determining ‘cultural’ proximity, it is clear cut that regardless of the model specification (I-VI), the technological diversity variable is always highly statistically significant and negative. Controlling for all the other variables likely to influence the project’s ‘cultural’ proximity, the lower the number of support technologies associated with the project, the higher the percentage of entities (SMEs and RTDs) with the same nationality as the 1st performer. This seems to convey the idea that technologically more homogenous (and specialized) projects tend to be less demanding in terms of international cooperation.

The above results are reinforced by the industry code variables. In both the Pavitt and OECD taxonomies, the coefficient estimates are negatively and highly significant. Given that high values for these variables translate into higher technology intensive projects, a negative coefficient indicates that these types of projects tend to attract entities belonging to a wider range of countries.

When one does not consider country specific weights, higher SME average costs seem to induce lower ‘cultural’ proximity as the coefficient estimates become negative and significant. This highlights the fact that more costly projects, from the perspective of SMEs, tend to attract a broader range of international partners. However, the RTD average yield does not seem to matter when explaining ‘cultural’ proximity.

The introduction of country specific weight does not impact severely on ‘cultural’ proximity – excluding the cases of Spain and France (for SMEs), the estimated coefficients are not significant. For these two countries, although coefficient estimates are small, they indicate that the higher the percentage of French or Spanish entities, the higher the promoter identity index. This reflects that fact that French and Spanish SMEs are more prone to cooperate with SMEs of the same nationality.

RSI strength variables seem to stress that projects involving a lower ‘cultural’ proximity are more demanding in terms of regional innovation supporting environments characterized by a high innovation capacity (patents applications and human capital intensity). Finally, higher employment rates seem to determine higher ‘cultural’ proximity.

The results regarding the factors explaining average promoter-participant distance (proxy for geographical distance) are, in general, in line with those obtained for the promoter identity index.

CRAFTs characterized by a higher degree of technological diversity determine, all other factors constant, a higher average distance between promoter SMEs and other participants. This reinforces the idea stressed above that in projects with a low the number of support technologies, the percentage of entities (SMEs and RTDs) with the same nationality as the 1st performer tends to be high, explaining in part the small average geographical distance between promoters and participants.

In contrast to the previous case, industry codes (both Pavitt and OECD) present no significant statistical coefficients, conveying the idea that project industry technological features are not relevant for explaining project average promoter-participant distance.

When we control for the intensity of SMEs and RTDs belonging to countries which have a greater presence in successful CRAFTs, the larger the size of the project, in terms of average RTD yield, the higher the average distance. From a cost perspective, however, high cost per SME projects include more geographically nearby partners.

It is interesting to note that the higher the weight of participants (SMEs and RTDs) from France, Germany (only in the case of SMEs), the Netherlands and the United Kingdom, the lower the projects' average promoter-participant distance. This might be explained by the fact that projects involving SMEs from these countries have a higher propensity to include RTDs of the same nationality than other countries. This decreases the average distance between the promoter and other project participants.

Excluding the employment rate, other RSI related variables do not seem to explain average distance among the different international cooperation projects. In fact, estimates are statistically insignificant for both patent and human capital variables. In comparison to the 'cultural' proximity case, where RSI strength seems to matter greatly, when it comes to geographical distance such a role is not underlined.

The above evidence suggests that our first hypothesis, ' H_1 : Technologically more complex projects are more likely to involve 'culturally' and geographically more distant partners', is corroborated. This might be explained by the fact that, when controlling for indicators of RSI strength (patent propensity, human capital intensity and labor market dynamics), projects encompassing a wider range of support technologies and belonging to high technology intensive industries (more science based, according to the Pavitt taxonomy, or high tech, following OECD typology) tend to require partners with more diverse and complementary technological capabilities. Such complementary is more

likely to be found in firms from different national systems of innovation, reflecting diverse, yet interrelated technological specialization fields.

As to our second hypothesis, ' H_2 : Larger international cooperative projects involve more culturally dissimilar and geographically distant partners', the evidence gathered only corroborates this when we introduce the SME or RTD country weights. In this case, and assessing project size by the yield accruing to participant RTDs, we conclude that the higher the (average) yield, the more internationalized the project is and, therefore, dissimilarity among the nationalities involved is more likely (lower 'cultural' proximity) and geographical distance is greater (average promoter-participant distance).

Given that RSI related variables, namely patent propensity and human capital, become significantly negative when related to 'cultural' proximity (although not statistically significant when it comes to geographical distance), we can point out that the data corroborates in part H_3 , that is, 'International cooperation projects involving 1st promoters of innovation-led regions (high patent propensity and high human capital levels) are culturally more distant'. Corroborating such a hypothesis could be interpreted as meaning that promoters of international cooperative projects who come from more endowed and innovative-led regions tend to lead more complex projects from a managerial point of view. In fact, to manage a wide range of firms of different nationalities implies considerable networking and relational competencies, which are more likely to be found in firms from well-developed regions. Firms that belong to weaker regions in terms of human capital and innovative performance may generally lack strong networking competencies, and they are thus induced to concentrate on more 'national', culturally nearby partners.



In the next chapter we perform an exploratory analysis and devise a preliminary test, through a case study of a specific project, of the 'success' criteria that the EU applies to classify CRAFTs and propose some pathways for future research.

Chapter 7. A preliminary and qualitative assessment on the perception of SMEs' regarding the 'success' of CRAFTs. A pathway for future research

7.1. What is the EU criterion for 'well-succeeded' CRAFTs?

The main empirical part of the present study relies on the analysis of 'well-succeed' CRAFT projects. In spite our considerable efforts,¹⁴ we could not find electronic or hard copy documents explaining the EU's criterion for classifying the selected CRAFT projects as 'well-succeed'. As reported in Chapter 5 the only explanation for the so-called success criterion was given, through a phone call, by Margarida Garrido, Portuguese contact person at Cordis.

Taking into account the reliance of the present study on 'well-succeed' projects the explanation put forward by Mrs Garrido – “The normal procedure to identify a well-succeeded CRAFTs is through the National Contact Points who search for finished projects from first Promoters of their countries and then ask them to provide a self-evaluation whether the project they were involved was or was not well-succeeded” – was quite insufficient from the scientific point of view. Moreover, given the 'mass marketing' strategy on EU's behalf both in its sites and documents, particularly in the *SMETechweb*, it was for us imperative to clarify a bit more such awkward situation.

At this stage some questions emerged needing for an (even if incomplete) answer:

1. Does EU's 'conventional criterion' of 'well-succeeded' projects reflect the reality?
2. When first promoters classify the projects in which they were involved as 'well-succeed', were they providing their personal opinion or that classification was the outcome of the several participants' judgments?
3. How projects' participants perceive their success?

¹⁴ First step was to contact the CORDIS Helpdesk by email. Because we haven't received any answer, we made further contacts by phone to the same entity. The information given was that only the EU's contact point for CRAFTs in Portugal could gave us an answer. Thus, we contacted GRICES (*Gabinete de Relações Internacionais da Ciência e Ensino Superior* - <http://www.grices.mces.pt/>), organization that manages the network of Portuguese EU's contact point, under the authority of the Minister of Science, Technology and Higher Education.

7.2. Selecting a particular CRAFT project among ‘well-succeeded’ CRAFTs

7.2.1. Methodology and general description of the selected CRAFT

We aim at testing the ‘success’ criterion of CRAFT projects in several dimensions. Thus, conditioned by the aim of the research, the choice of in-depth and comparative case study methodology was particularly straightforward. In fact, the methodology employed here, combining qualitative and quantitative elements, it is considered to be more appropriate when ‘how’ and ‘why’ questions are being asked about a past or current phenomenon drawing on multiple sources of evidence (Yin, 1994). This is the case with the present research. Although results obtained through this methodology cannot be generalized to populations (statistical generalizations) they can be, nevertheless, generalized to theoretical propositions - analytical generalizations (Yin, 1994).

From our database and directory where we stored the 118 ‘pdf’ files corresponding to all the CRAFTs analyzed in Chapters 5 and 6, we randomly choose one for case study analysis. The selected CRAFT (Table 17) is a consortium of three SMEs from France (1st Promoter), Germany and Switzerland, and two RTDs, from France and Switzerland.

According to the document that describes the chosen CRAFT (EU, 2000), “[t]he idea behind the UDICOS development work came from an unusual source – a dental patent ... an idea based on bone conduction (osteophony), the transmission of sound to the eardrum via the teeth and jawbone.” The first promoter, a French SME, bought the patent with the intention of developing a hearing aid that could be fitted in the mouth. Another French company heard about the patent and had the idea of adapting it to help divers talk to each other under water. Finding a partner with the necessary expertise to produce this proved difficult, but eventually a former East German company was identified. According to the same document (EU, 2000), with the help of a German RTD, the German SME realized the benefits of participation and accepted the invitation to join the project. The state-of-the-art research into signal propagation in water required for this application was carried out by the Swiss research organization (i.e., a RTD). The second step was the development of an orientation system, “...which [would] provide the diver with a user-friendly display of the location and orientation of support vessels on the surface, uses an acoustic field generated from the ship and

triangulation techniques”. The selected partner to be in charge of this job was a Swiss “...spin-off company composed of young postgraduates from the University of Lausanne. This company was approached because many of its staff was involved in a university project aimed at locating and retrieving skiers caught in avalanches, and their know-how readily lends itself to this application”.

The project was developed under EU MAST (Marine, Science and Technology) program, from the 4th FP, with a cost of one million euros and financed with 416.000 euros.

Table 17: General characteristics of the selected CRAFT

Industrial sector:	NACE 32 (Manufacture of radio, television and communication equipment and apparatus)
Supporting Technologies	0004 Acoustics; 0120 Communication Engineering/Technology; 0192 Electronics, Electronic Engineering
Duration	From January, 1998 to December, 2000
Program	MAST III
Project Cost	€1,000,000
Range of SME Contribution	€42,000 – €250,000
EC Funding	€416,000

Source: ‘PDF’ file gathered from <http://sme.cordis.lu/craft/home.cfm>, accessed on 30 April 2005.

Providing an additional description of the project in terms of its industry nature, we are able, using Table 32, described in Appendix 3, to classify it in a more detailed and comparable way to the analysis undertaken in Chapter 5. Accordingly, the selected CRAFT came from the Electrical sector (SIC) and might be classified as ‘high-technology’ (cf. OECD taxonomy) and ‘science based’ (cf. Pavitt taxonomy).

In synthesis, the project encompassed the building and developing of a system of communication and localization to scuba divers. The system should both enable the communication between divers and between divers and the support vessels. Its main goals were to reduce effectively the risk of the activity (as diving can be hazardous), make scuba diving “...a more social experience”, and provide a less expensive alternative - “... €500 for the plug-in version (a third of the price of mask-based communication systems)” - to the around 3 million scuba divers in Europe and, particularly to the 10 – 20% of them that dive for professional reasons (e.g. policemen, marine scientists, diving instructors).

7.2.2. The ‘official’ outcome of the selected CRAFT

According to EU (2000), the five partners had, at that time (July 2000), a product which was ready for the market and had been exhibited at the Third SME Technology Days in Porto in June 2000. The device was available in two formats: “...the first [was] a listen-only device which the divers plug into a portable unit that they carry with them, rather like an underwater ‘walkman’. This allow[ed] them to listen to pre-recorded information, for example a guided tour of an underwater wreck, or music to help pass the time during in-water decompression stops ... the second version allow[ed] two divers to plug into an ‘intercom’ device and engage in two-way conversation. In this instance, the divers’ mouthpieces ha[d] two actuators, one for receiving sound, and one for transmitting”. As the leaflet further advances “... this version [was] expected to be welcomed by diver training schools around the world, as it enable[d] in-water dialogue between instructors and trainees. The only disadvantage of the system [was] that the divers ha[d] to stay in relatively close proximity, the distance between them being limited to the length of the connecting cable”.

Additionally, a wireless version of the device was expected to be ready in October 2000, to be commercialized one year later. At that time, the orientation system was still at an early stage and the feasibility of the application had been established and work then was focused on the real-time aspects of the system and its portability.

According to the project’s descriptors “the communication and orientation systems [were] being designed to work together as well as independently, and it [was] hoped that they [would] bring about a major reduction in diving fatalities”.

7.3. The questionnaire and its implementation

In order to gather personal but objective and comparable information on the project in study, from each (of the three) SMEs participants, we device a purposefully made questionnaire that was sent by e-mail.¹⁵

The questionnaire was structured into five main parts: 1) general description of the organization; 2) organization’s cooperation history; 3) information concerning the CRAFT in question; 4) account of the relationship between CRAFTs partners; and 5) general considerations on R&D cooperation.

¹⁵ See the questionnaire in the Appendix 4.

Our ultimate objective was to test whether the success perception of each participant matched. Nevertheless, albeit more secondary, we also analyze the importance attributed (by SMEs participants) to the several potential factors related to R&D international cooperation, which might constitute interesting evidence for developing in future researches ventures.

Two out the three SMEs participants filled the questionnaire. The one (German SME) that failed in responding justified its no answer by arguing that although it took part in the project,

“...our role was very unimportant and there are no results we could use” (e-mail response collected on 20 March 2006).

Both firms were very young when the cooperation associated with the selected CRAFT began (1998). The 1st Promoter was in business for only 4 years (initiated its activity in 1994) and the Swiss company was in business for less than one year.

The 1st Promoter is from Toulouse, France (*Midi-Pyrénées*, NUT level 1 nomenclature) and had no previous history of R&D cooperation. The Swiss firm is from Lausanne and had already cooperated with universities and research institutes in public financed projects (in part due to its nature of spinoff) previously to that CRAFT.

7.4. Cooperation relationship between partners of the selected CRAFT – a brief account based on the survey results

As referred above, in our exploratory survey we include some questions related to aspects of relationship between the cooperators. The aims were to assess the type and of the contacts, and to perceive the several dimensions of proximity mentioned by the literature (e.g., Boschma, 2005a,b), namely geographical, cognitive, institutional and social/cultural.

As it is possible to observe in Table 18, the e-mails seem to be the most used way of contact between participants. Notwithstanding, firms responses are not convergent both when considering the frequency of contacts during the project and the forms of contacts used. However, taking the testimony of the Swiss Firm, the e-mails were used more to discuss bureaucratic aspects related to project management than for sharing or transferring knowledge.

Table 18: Frequency (0: never; 1: sometimes; 2: often), and type of contacts between partners *during* the project

Forms of contact	1 st Promoter						Swiss firm					
	National partners			International partners			National partners			International partners		
	0	1	2	0	1	2	0	1	2	0	1	2
Meetings		x			x						x	
Phone calls			x		x			x				
E-mails			x			x		x			x	
Other internet forms (chat, forum ...)	x			x								
Personal contacts		x			x			x				

The divergence of points of view remains when we inquired on the level of cooperation between the national and international partners (Table 19). The 1st Promoter is more optimistic and considered both very good. By opposition, the Swiss firm considered them inexistent or almost inexistent.

Table 19: Classification of the level of cooperation between partners (0: inexistent; 1: very poor ... 5: very good).

	1 st Promoter												Swiss firm											
	National partners						International partners						National partners						International partners					
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
With all the companies												x					x							x
With the companies from your industry																	x							x
With the companies from other industries												x					x							x
With larger companies						x											x							x
With smaller companies												x					x							x
With the RTDs						x												x						x

It is important also to uncover factors the CRAFT participants consider to have constituted more difficult hurdles in this cooperation project (Table 20). Similar to previous analysis, the 1st promoter showed a more cheering perspective whereas the Swiss firm was clearly more negative. They nevertheless agree that the most difficult

aspects were the diversity of technologies and the differences in the type of organizations (namely regarding the international partners).

Table 20: Classification of the level of difficulty (0: easy ...5: very difficult) of some factors in the relation with the other partners

	1 st Promoter												Swiss firm											
	National partners						International partners						National partners						International partners					
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Language	x						x						x						x					
Geographical distance	x							x					x							x				
Trust	x						x						x							x				
Acquisition of knowledge		x						x						x							x			
Transmission of knowledge		x						x						x							x			
Diversity of technologies used		x							x					x							x			
Different kinds of organizations		x							x					x							x			

We also try to understand whether the (eventual) cooperative relation between partners persisted after the end of the project (Table 21). The answers from the two firms in analysis were almost antagonic. The 1st Promoter stated that maintained frequent contacts with all the SMEs partners; in contrast the Swiss firm that contacted sometimes but only with national partners.

Table 21: Frequency of contacts (0: no contact; 1: sometimes; 2: often), and type between partners (national and international) *after* the end of the project

Contacts with...	1 st Promoter						Swiss firm					
	National partners			International partners			National partners			International partners		
	0	1	2	0	1	2	0	1	2	0	1	2
All the partners		x				x	x			x		
Some of the partners			x			x		x			x	
Related with the project			x			x	x				x	
Other R&D financed projects (public or European Union funded)	x			x			x				x	
Other private R&D projects	x			x			x				x	
Commercial agreement			x	x			x				x	
Personal contacts			x			x		x			x	

7.5. Reliability of the success perception of SMEs participants regarding to the CRAFT in analysis – a preliminary assessment

Before entering in an in-depth analysis of the questionnaire in what concern the ‘success’ criterion, we found interesting and informative to detail the contents of e-mails sent by SMEs participants in the selected CRAFT project as they provide us with a first approximation to the degree of convergence/divergence of opinions regarding the CRAFT’s ‘success’.

The Swiss SME produced the following intriguing and worrisome statement:

“... to be honest, for us this kind of project was a waste of time and energy. Even after several years have passed we still need to fulfill some formularies. European projects are mainly a way for laboratories to pay, year after year, lots of R&D assistants to learn their job. In the majority of cases the technical and commercial results for SMEs are ridiculous and hidden behind non sense pseudo-administrative reports that hundreds of people are paid to read and check whether the reference numbers on each page are exact. Apart from this, people talk for weeks about consortium agreements, take planes, go to restaurants, wonder how they will have more money from Europe the next year, instead of doing in a serious manner the job they have been paid for”.
(e-mail response collected on 20 March 2006)

It is clear from this statement that some discrepancy exists between the contents of the ‘pdf’ file (EU, 2000) and the perception of the two (out of three) SMEs participants mentioned above. Indeed, as referred earlier, whereas the German SME considered that its participation was, almost, inexistent and that no benefit was gathered from ‘eventual’ project’s results, the Swiss SME claimed that the project was a waste of time and energy.

7.6. Reliability of the success perception of SMEs participants regarding to the CRAFT in analysis – a more systemic view based on the questionnaire

As it was mentioned earlier the French firm participated in this CRAFT obviously because promoted it and the Swiss firm was invited by a RTD.

The following table presents potential reasons for firms participating in international R&D cooperative agreements, in particular in CRAFTs projects, and the answers of the two SMEs, the French (1st promoter) and the Swiss.

Table 22: Importance attributed to the different potential reasons for engaging in R&D international cooperation (CRAFT) (1: no importance ... 5: very important)

Reasons	1 st Promoter					Swiss participant				
	1	2	3	4	5	1	2	3	4	5
In response to key customer needs			x			x				
In response to a market need		x				x				
In response to technology changes						x				
To reduce the risk of R&D			x			x				
To broaden product range					x	x				
To reduce R&D costs					x	x				
To improve time to market						x				
In response to competitors						x				
In response to management initiative			x			x				
To be more innovative in product development					x	x				
To take advantage of EU funding		x						x		
In response to R&D/firm invitation										x

There is substantial discrepancy between the two SMEs' answers in what respects of their reasons for being part of this CRAFT project. The promoter's answers are more in line with some of the 'natural' reasons for inter-firm R&D cooperation, i.e., broaden product range, reduce R&D costs and risks, be more innovative, etc. (cf. Chapter 2). The Swiss SME's reasons for being involved was largely passive – to respond to the RTD invitation, and to take advantage of EU funding.

For the 1st Promoter, the project positively contributed almost in every dimension tackled (cf. Table 23), with a more noticeable effect however in terms of the 'incorporation of new technology' and 'making the product development less costly'. The Swiss firm failed to recognize any positive economic and/or managerial effect from its participation.

Table 23: Impact of CRAFT participation on SMEs' product/process development – degree of agreement (0: not agree at all ... 5: absolutely agree)

Effects	1 st Promoter					Swiss participant				
	1	2	3	4	5	1	2	3	4	5
Allows development to adapt better to uncertainty			x				x			
Accelerates product/process development			x				x			
Allows development to respond better to market opportunities		x					x			
Enhances competitive benefits arising through development			x				x			
Facilitates the incorporation of new technology in development				x			x			
Makes development more responsive to supplier needs			x				x			
Makes development more responsive to customer needs			x				x			
Makes product/process development less costly				x			x			
Simplify product/process development		x					x			
Makes development easier to control		x					x			

When asked about the outcome of this cooperation (Table 24), once more there was almost no agreement- the two firms agreed only in what concerns the fact that the project enabled them to access and accumulate 'new knowledge'.

It is ill at ease to find that the participants reckon that the *same* project generate different outcomes. For instance, whereas for the Swiss firm one of the results of the project was a prototype, the 1st Promoter did not refer it. In contrast, the Swiss firm apparently neglected the existence of a patent, a new product, and a new firm, related to the project, elements that the 1st Promoter assured that existed.

Table 24: Results of the selected CRAFT project

Results	1 st Promoter	Swiss participant
Nothing		
New knowledge	x	x
Prototype		x
Patent	x	
New product or service	x	
New process		
New organization	x	

Although so far nothing has been said about the project ‘success’, it is possible to advance that non-negligible differences emerge in the participants’ perception of the project impact and, utmost, its results. Given the straightforwardness of this latter dimension, we might conclude that either the relationship between participants in the selected CRAFT was far from the presupposed cooperation and/or the answer of (some) participants did not reflect the reality accurately.

Further apparent disagreements were found when we asked firms their opinion on the ‘quality’ of the cooperation relationship associated with the selected CRAFT (see Table 25). The 1st Promoter consider on overall that the relationship between participants were of ‘high-quality’, in the sense that this firm do not acknowledge any problem of strategic/goal divergence, lack of trust, problems with partners, personal clashes or lack of commitment.

Table 25: Degree of agreement concerning the cooperation relationship within the selected CRAFT (0: not agree at all ... 5: absolutely agree)

Questions	1 st Promoter						Swiss firm					
	0	1	2	3	4	5	0	1	2	3	4	5
There were strategic/goal divergences		x								x		
There were partner problems		x								x		
There were cultural mismatch		x								x		
There was insufficient trust	x									x		
There was operational/geographical overlap	x									x		
There was personal clashes	x									x		
There was lack of commitment		x								x		
There was unrealistic expectations/time			x									x
There was asymmetric incentives				x						x		

In contrast, the Swiss firm seemed to encounter several problems (although not extremely acute) at several levels: goal divergence, insufficient trust, personal clashes and so on. Two items present a relatively accordance, the existence of some (1st promoter) up to severe (Swiss firm) unrealistic expectations and asymmetric incentives.

Given what was exposed so far, it is of no surprise that the Swiss firm considered that no benefit was derived from the participation of the selected CRAFT, whereas the 1st Promoter found substantial relevant benefits (Table 26).

Table 26: The perception of CRAFT participants on the benefits accrued to the organization

Benefits	1 st Promoter	Swiss firm
Nothing		x
Improvement on the organization knowledge base	x	
Improvement of the products/services portfolio	x	
Improvement of the production process	x	
New commercial agreements	x	
Sales on new markets		
International contacts	x	
Participation on other companies capital		
Participation by other companies in your capital		

Finally when asked to rate the degree of success (0: unsuccessful ... 5: extremely successful) of the selected CRAFT the opinions remained at the extremes with the 1st Promoter considering the project highly successful (attributing a grade 4) and the Swiss firm classifying it as nearly unsuccessful (grade 1).

For all the reasons detailed in this section it is justified that the 1st Promoter is willing to participate in future CRAFT projects whereas the Swiss do not envisage such situation.

7.7. Looking for ways to improve CRAFT outcomes – the participants perspective

Finally, in order to assess in which ways would it be possible to improve CRAFT projects, we asked the selected CRAFT participants to give their opinion about several items associated to CRAFT rules, namely, the participation of RTDs; level of EU funds; number of countries involved; consortia management; information (sites, databases, answer to doubts, etc.) provided by the EU; control of the consortia work by the EU, and final evaluation of the project results by the EU (Table 27).

According to the first promoter, the participation of RTDs; control of the consortia work by the EU, and the final evaluation of the project results by the EU were positive aspects to be highlighted. In contrast, it perceived the level of EU funds and the number of countries involved as inadequate.

Again, the discrepancy of answers make difficult to get conclusions. Both partners classify high the RTDs participation and disagree about the level of EU funds (1st Promoter consider them low).

No positive aspects were underlined by the Swiss participant and it is curious that we obtain opposite answers related to the items ‘control of consortium work by the EU’ and the ‘final project evaluation’, demonstrating once more that the existing ‘success’ criterion is at the best debatable.

Table 27: Classification of some aspects related with CRAFT projects

Factors	1 st Promoter			Swiss firm		
	-	0	+	-	0	+
Participation of RTDs			x		x	
Level of European Union funds	x				x	
Number of countries involved	x			x		
Consortia management		x		x		
Information (sites, databases, answer to doubts, etc.) provided by the European Union		x		x		
Control of the consortia work by the European Union			x	x		
Final evaluation of the project results by the European Union			x	x		

According to the 1st promoter (the Swiss firm did no answer the question), *for a successful cooperative relation* (Table 28) the most important factors are the existence of a clearly defined objectives agreed by all parties, to have a collaboration champion, and top management commitment.

Moreover, it stressed the relevance of personal relationships mutual trust/openness/honesty, and mutual understanding for achieving prosperous and sustainable cooperative relations.

Last but not least, it emphasized the significance of flexibility, pursuing and assurance of mutual benefit, equality in power/dependency and the suitability of combining complementary strengths.

Table 28: Factor importance for a successful cooperative relation (0: not important ... 5: extremely important).

	1 st Promoter						Swiss firm					
	0	1	2	3	4	5	0	1	2	3	4	5
Clearly defined objectives agreed by all parties						x						
Clearly defined responsibilities agreed by all parties			x									
Realistic aims			x									
Defined project milestones			x									
Reduce R&D costs			x									
Collaboration champion						x						
Commitment at all levels			x									
Top management commitment						x						
Personal relationships						x						
Staffing levels			x									
Frequent communication			x									
Mutual trust/openness/honesty						x						
Regular progress reviews			x									
Deliver as promised			x									
Flexibility						x						
Mutual benefit						x						
Equality in power/dependency						x						
Equality of contribution		x										
Mutual understanding						x						
Complementary strengths						x						
Past collaboration experience		x										
Geographical proximity		x										
Sharing the same knowledge base		x										
Sharing economic-financial relations				x								
Long lasting personal relationship		x										
Sharing common values (laws, property rights, culture)			x									



The main conclusion from the analysis undertaken in this chapter to one randomly selected CRAFT project is that the adopted or publicized ‘success’ criterion of CRAFTs is, at the best, non consensual and thus likely to be controversial.

The discrepancy between answers of CRAFT participants, together with the absence of published explicit and clear evaluation criterion, which could involve all the participants of each CRAFT, demonstrate that this subject deserves further and solid research.

This latter could be pursued extending the analysis performed in the present chapter to all the participants in the so-called ‘well-succeeded’ CRAFTs.

Such task, although gigantic would potentially enable rigorous policy recommendation regarding the functioning, managing and surveillance of each project, which could be used to re-design this kind of funded programs with the aim of providing increased efficacy and efficiency.

We do hope that this rather exploratory and preliminary analysis might encourage further research in this under explored area.

**Part IV – Main conclusions and policy considerations for the
development of public R&D instruments targeting
SMEs**

Chapter 8. Main conclusions and policy considerations

In this work we attempt to analyze in a first stage how proximity, in its different perspectives (geography, culture and technology), might be relevant for international R&D cooperation.

Although, as we have exposed, there have been a lot of researchers on the inter-firms cooperation and all the aspects related with it (e.g. the nature of knowledge and proximity relevance), international R&D cooperation encompassing small, low tech firms has been rather under investigated.

The present thesis aimed at addressing such gap by providing further and new evidence on R&D cooperation in relatively low tech SMEs, analyzing in particular the effect of technological complexity, project size, and the strength of the Regional Systems of Innovation (RSI) on the cultural and geographical proximity of partners engaged in formal international R&D networks projects.

In concrete, we provided here a detailed characterization of CRAFT projects which were considered by CORDIS as ‘well-succeeded’. We built a database with 118 of such projects. This CRAFTs projects involved SMEs (in their majority, as shown, low and medium tech) who cooperated in R&D. The participants (SMEs and RTDs) could or could not be located in the same country and/or region; they could belong to similar or different technological areas.

Through econometric estimation procedures we assessed the relationship between technology and (cultural and geographical) proximity in international R&D networks, evaluating in particular the main determinants of cultural and geographical proximity in CRAFT international R&D cooperation, seeking to analyze to what extent R&D cooperation between low tech firms involved the so-called ‘de-territorialisation of closeness’.

The main results of our estimation were firstly that technologically more complex projects were more likely to involve ‘culturally’ and geographically more distant partners; secondly, larger international cooperative projects involved more culturally dissimilar and geographically distant partners; and finally, that international cooperation projects involving 1st promoters of innovation-led regions (high patent propensity and high human capital levels) were culturally more distant.

This latter finding could be interpreted as meaning that promoters of international cooperative projects who came from more endowed and innovative-led regions (high quality RSI) tend to lead more complex projects, from a managerial point of view, and, by opposition, firms that belong to weaker regions (low quality RSI) in terms of human capital and innovative performance may generally lack strong networking competencies, being thus constrained to concentrate on more ‘national’, culturally nearby partners.

Summing up, such results based on international R&D cooperation projects involving SMEs with relatively weak competencies in R&D, evidence, to some extent, a pathway for ‘de-territorialisation of closeness’.

In a second stage, we pursued a case study analysis of a selected CRAFT project. The aim was to investigate further the adequacy of the ‘conventional’ ‘success’ criterion adopted by the EU to classify the CRAFT projects.

The main conclusion from the analysis undertaken in this chapter to one randomly selected CRAFT project is that the adopted or publicized ‘success’ criterion of CRAFTs is, at the best, non consensual and thus likely to be controversial.

The discrepancy between answers of the selected CRAFT participants, together with the absence of published explicit and clear evaluation criterion, which could involve all the participants of each CRAFT, demonstrated that this subject would be worthy of supplementary and fundamental research.

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Appendix

Appendix 1. Boundaries of R&D

Table 29: Boundaries between R&D and education and training at ISCED level 6¹⁶

	Education and training at level 6	R&D	Other activities
Teachers	Teaching students at level 6		
	Training students at level 6 in R&D methodology, laboratory work, etc.		
		Supervision of R&D projects required for student qualification at level 6	
		Supervision of other R&D projects and performance of own R&D projects	
			Teaching at levels lower than level 6
			Other activities.
Postgraduate Students	Course work for formal qualification		
		Performing and writing up independent studies (R&D projects) required for formal qualification	
		Any other R&D activities	
			Teaching at levels lower than level 6
			Other activities

Source: Frascati Manual, OECD, 2002: 37.

¹⁶ The ISCED-97 level 6 category corresponds to the "...second stage of tertiary education – leading to an advanced research qualification" (Frascati Manual, OECD, 2002: 98).

Table 30: Some cases at the borderline between R&D and other industrial activities

Item	Treatment	Remarks
Prototypes	Include in R&D	As long as the primary objective is to make further improvements
Pilot plant	Include in R&D	As long as the primary purpose is R&D
Industrial design and drawing	Divide	Include design required during R&D. Exclude design for production process
Industrial engineering and tooling up	Divide	Include “feedback” R&D and tooling up industrial engineering associated with development of new products and new processes. Exclude for production processes
Trial production	Divide	Include if production implies full-scale testing and subsequent further design and engineering. Exclude all other associated activities
After-sales service and trouble-shooting	Exclude	Except “feedback” R&D
Patent and license work	Exclude	All administrative and legal work connected with patents and licenses (except patent work directly connected with R&D projects)
Routine tests	Exclude	Even if undertaken by R&D staff
Data collection	Exclude	Except when an integral part of R&D
Public inspection control, enforcement of standards, regulations	Exclude	

Source: Frascati Manual, OECD, 2002: 41.

Appendix 2. Pavitt's classification

Table 31: Pavitt taxonomy

Determinants of technological trajectories					Measured characteristics					
Firm category (1)	Base sector (2)	Sources of technology (3)	Type of strategy (4)	Appropriation means (5)	Technological trajectories (6)	Sources of technological processes (7)	Product and innovation process relative balance (8)	Relative size of innovative firms (9)	Intensity and direction of technological diversification (10)	
Supplier dominated	Agriculture, construction, services and traditional manufacture	Suppliers research services extension; big customers	Price sensitive	No technical (e.g. registered marks, marketing, esthetical design)	Cost reduction	Suppliers	Process	Small	Low, vertical	
					Cost reduction (product design)	Internal, suppliers	Process	Large	High, vertical	
Production intensive	Scale intensive	Materials (steel, glass); assembling (durables of consuming & autos)	Engineering and production departments; R&D	Price sensitive	Process confidentiality and know-how; patents; dynamic learning	Product design	Internal, customers	Product	Small	Low, concentric
	Specialized suppliers	Machinery and instruments	Design and customers developments	Performance sensitive	R&D, know-how, patents, process confidentiality, dynamic learning	Mixed	Internal, suppliers	Mixed	Large	Low, vertical and high, concentric

Source: Pavitt (1984)

Appendix 3. Conversion of ‘well-succeeded’ CRAFTs into SIC, OECD and Pavitt taxonomies, based on original NACEs and supporting technologies

Table 32: Authors’ conversion of original projects NACEs into SIC, OECD and Pavitt taxonomies

NACE		SIC		OCDE	Pavitt
Code	Description	Code	Description		
01	Agriculture, hunting and related service activities	1	Agriculture, fishery and extractive industry	Low-tech	Supplier Dominated
05	Fishing, operation of fish hatcheries and fish farms, service activities incidental to fishing				
11	Extraction of crude petroleum and natural gas, service activities incidental to oil and gas extraction, excluding surveying				
14	Other mining and quarrying				
15	Manufacture of food products and beverages	2	Food and beverages	Low-tech	Scale Intensive
18	Manufacture of wearing apparel, dressing and dyeing of fur	3	Textiles	Low-tech	Supplier Dominated
19	Tanning and dressing of leather, manufacture of luggage, handbags, saddlers, harness and footwear				
20	Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials	4	Wood industries	Low-tech	Scale Intensive
24	Manufacture of chemicals and chemical products	5	Chemicals and plastics	Medium-tech	Science Based
25	Manufacture of rubber and plastic products				
26	Manufacture of other non-metallic mineral products	6	Non-metallic minerals	Medium-tech	Supplier Dominated
27	Manufacture of basic metals	7	Basic metals and fabric metal products	Medium-tech	Scale Intensive
28	Manufacture of fabricated metal products, except machinery and equipment				
29	Manufacture of machinery and equipment n.e.c.	8	Machinery	Medium-tech	Specialized Suppliers
31	Manufacture of electrical machinery and apparatus n.e.c.	9	Electrical	Medium-tech	Science Based
32	Manufacture of radio, television and communication equipment and apparatus			High-tech	
33	Manufacture of medical, precision and optical instruments, watches and clocks	10	Precision instruments	High-tech	Science Based
34	Manufacture of motor vehicles, trailers and semi-trailers	11	Manufacture of transports	Medium-tech	Scale Intensive
35	Manufacture of other transport equipment				
36	Manufacture of furniture, manufacturing n.e.c.	12	Other manufacture	Medium-tech	Supplier Dominated
37	Recycling			Low-tech	
40	Electricity, gas, steam and hot water supply	13	Utilities and construction	Low-tech	Scale Intensive
45	Construction				

(...)

(...)

NACE		SIC		OCDE	Pavitt
Code	Description	Code	Description		
52	Retail trade, except of motor vehicles and motorcycles, repair of personal and household goods	14	Retail and Wholesale	Low-tech	Supplier Dominated
60	Land transport, transport via pipelines	15	Transport and telecommunication services	Low-tech	Supplier Dominated
64	Post and telecommunications			High-tech	Scale Intensive
72	Computers and related activities	16	Computing and R&D	High-tech	Specialized Suppliers
73	Research and experimental development on natural sciences and engineering				
85	Health and social work	17	Health and recreational services	Low-tech	Supplier Dominated
90	Sewage and refuse disposal, sanitation and similar activities	18	Other services	Low-tech	Supplier Dominated
92	Recreational, cultural and sporting activities			Low-tech	Supplier Dominated
93	Other service activities				

Note: For the necessary conversions adjustments we used original projects' supporting technologies.

Appendix 4. Questionnaire constructed for surveying CRAFTs' participants

Survey to CRAFTs Participants - Ref: _____

1. Organization description

Name of the organization: _____ Consortia position: _____
Begin of activity (year): _____
Localization (City, Region): _____
Activity (NACE): _____
Contact (Responsible by the survey; phone; e-mail): _____

2. Organization cooperation history (Please put an 'X' on the selected case)

Before this project

Did your organization participate in any R&D cooperation with other entities?

Yes	No
☐	☐

If you answered 'Yes' to the last question, please put an 'X' (you can put more than one) in the selected cases

The projects were...

...with other companies	National	☐	International	☐
...with universities or research institutes (RTD)	National	☐	International	☐
...financed with public funds	National	☐	International	☐
...other CRAFT projects	Yes	☐	No	☐
...other European Union programs	Yes	☐	No	☐

3. The participation on this CRAFT

Please explicit the way your **organization got involved in this CRAFT project** (please put an 'X' in the selected case (only one))

You promote it	☐
By invitation from one <u>national</u> company	☐
By invitation from one <u>international</u> company	☐
By invitation from one <u>national</u> RTD	☐
By invitation from one <u>international</u> RTD	☐
By invitation from the national contact point	☐
By the 'look for partners' database from the European Union	☐
Other (explicit): _____	☐

How important (0: not important at all; ...; 5: extremely important) were the following **reasons for** your organization to **engage** in this **cooperative** project:

	1	2	3	4	5
In response to key customer needs					
In response to a market need					
In response to technology changes					
To reduce the risk of R&D					
To broaden product range					
To reduce R&D costs					
To improve time to market					
In response to competitors					
In response to management initiative					
To be more innovative in product development					
To take advantage of EU funding					
In response to R&D/firm invitation					

Other: _____

Concerning the **effects of CRAFT cooperation** on the **product/process development**, state your **degree of agreement** (0: not agree at all; ...; 5: absolutely agree) with the following statements:

	0	1	2	3	4	5
Allows development to adapt better to uncertainty						
Accelerates product/process development						
Allows development to respond better to market opportunities						
Enhances competitive benefits arising through development						
Facilitates the incorporation of new technology in development						
Makes development more responsive to supplier needs						
Makes development more responsive to customer needs						
Makes product/process development less costly						
Simplify product/process development						
Makes development easier to control						

Please explicit the **result of this CRAFT project**, put an 'X' (you can put more than one) in the selected cases

Nothing	☐
New knowledge	☐
Prototype	☐
Patent	☐
New product or service	☐
New process	☐
New organization	☐
Other (explicit): _____	☐

Concerning the **CRAFT cooperation** relation state your **degree of agreement** (0: not agree at all; ...; 5: absolutely agree) with the following statements:

	0	1	2	3	4	5
There were strategic/goal divergences						
There were partner problems						
There were cultural mismatch						
There was insufficient trust						
There was operational/geographical overlap						
There was personal clashes						
There was lack of commitment						
There was unrealistic expectations/time						
There was asymmetric incentives						

List the **benefits** your organization had after the participation in **this CRAFT project** (you can choose more than one 'X')

Nothing	
Improvement on the organization knowledge base	
Improvement of the products/services portfolio	
Improvement of the production process	
New commercial agreements	
Sales on new markets	
International contacts	
Participation on other companies capital	
Participation by other companies in your capital	
Other (explicit): _____	

Please classify, from '0' (no success) up to '5' (very successful), the success of **this** project

0	1	2	3	4	5

After this project, have you participated (or intend to) in other CRAFT projects?

Yes ☐ No ☐

4. Relationship between this project's partners

Classify the **frequency of the contacts** (0 – never; 1- sometimes; 2- often) between your organization and the other partners during the project and the means used to (you can choose more than one 'X')

	National partners			International partners		
	0	1	2	0	1	2
Meetings						
Phone calls						
e-mails						
Other internet means (chat, forum, blog, etc.)						
Personal contacts						
Other: _____						

Classify the **level of cooperation** (**0 – Inexistent; 1- bad ... 5 – very good**) between your organization and the other partners.

(Please put an 'X' on the selected cell)

	National partners						International partners					
	0	1	2	3	4	5	0	1	2	3	4	5
With all the companies												
With the companies from your industry												
With the companies from other industries												
With bigger companies												
With smaller companies												
With the RTDs												

Classify the following aspects, in terms of **level of difficulty** to your organization (**0 – easy; ...; 5 – very difficult**), in the relation with the other partners. (Please put an 'X' in the selected cell)

	National partners						International partners					
	0	1	2	3	4	5	0	1	2	3	4	5
Language												
Geographical distance												
Trust												
Acquisition of knowledge												
Transmission of knowledge												
Diversity of technologies used												
Different kinds of organizations												

Refer the **frequency of contacts** (**0 – No contact; 1- sometimes; 2 – often**) with this project's partners, **after it ended**.

(Please put an 'X' on the selected cell)

	National partners			International partners		
	0	1	2	0	1	2
All the partners						
Some of the partners						
Related with the project						
Other R&D financed projects (public or European Union funded)						
Other private R&D projects						
Commercial agreement						
Personal contacts						
Other: _____						

5. General considerations on R&D cooperation

How important to you (0: not important at all; ... 5: extremely important) are the following factors for a **successful cooperative** relation:

	0	1	2	3	4	5
Clearly defined objectives agreed by all parties						
Clearly defined responsibilities agreed by all parties						
Realistic aims						
Defined project milestones						
Reduce R&D costs						
Collaboration champion						
Commitment at all levels						
Top management commitment						
Personal relationships						
Staffing levels						
Frequent communication						
Mutual trust/openness/honesty						
Regular progress reviews						
Deliver as promised						
Flexibility						
Mutual benefit						
Equality in power/dependency						
Equality of contribution						
Mutual understanding						
Complementary strengths						
Past collaboration experience						
Geographical proximity						
Sharing the same knowledge base						
Sharing economic-financial relations						
Long lasting personal relationship						
Sharing common values (laws, property rights, culture)						

Classify as positive or negative the following **aspects related with the CRAFT projects** (0 – negative; 1- neutral; 2- positive), please put an ‘X’ (you can put more than one) in the selected cases

	0	1	2
Participation of RTDs			
Level of European Union funds			
Number of countries involved			
Consortia management			
Information (sites, databases, queries, etc.) provided by the European Union			
Control of the consortia work by the European Union			
Final evaluation of the project results by the European Union			