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Key-factors of international technology transfer within a Triple Helix framework

The case of Enterprise Europe Network

by

Ana Carina Araújo

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Supervised by Aurora A.C. Teixeira

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Biographic Note

Ana Carina Pena Araújo was born in 25th November 1983 in Vila do Conde, Portugal.

In 2001, she starts her degree in Management at the University of Porto School of Economics and Business. During that period she worked in FEP Junior Consulting and in 2007 she do the internship at the Oporto business angels association. In the same year she moves to Spain to work in an international trade consulting company under the Leonardo da Vinci program.

Since 2008, she is working at Agência de Inovação in international technology transfer projects. Currently, she is a master candidate in Innovation Economics and Management at the University of Porto School of Economics and Business.

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Abstract

Being recognized that science and technology are inductors of economic development (Etzkowitz, 2003), the emergence of the knowledge-based economy creates an overlay of communications and expectations that caused an institutional restructure based on innovative capacities. Thereupon, the Triple Helix of university-industry-government interactions plays an increasing role in the economic development. While the literature tends to concentrate in the university-industry relation, we go forth with the attempt of operationalising the university-industry-government relation established in a technology transfer context.

Based on Enterprise Europe Network, a European program that supports innovation and internationalization and links universities, companies and governments across Europe, this dissertation aims to study the key-factors that foster technology transfer among the triad university-industry-government in an international context.

Contrary to the hypotheses put forward, ours results, based on 71 technological Partnership Agreements (PAs), indicate that EEN's human capital endowments and absorptive capability act as barriers to the international technology transference. In contrast, successfully transfer technology at an international level, within a Triple Helix framework, is associated with network connectedness, trust and prior experience in international or technological projects. Interestingly, PAs associated to EEN partners that provide their collaborators adequate training in technology transference related issues, that present substantial past experience in international or technological projects, and that possess a wide networks are of the ones that achieve better performances in terms of international technology transfer.

Keywords: International technology transfer; Triple Helix; university-industry-government relations; Enterprise Europe Network

JEL-codes: O32; O33; O38

Index

Biographic Note ..... **i**

Acknowledgments ..... **ii**

Abstract ..... **iii**

Introduction **1**

Chapter 1. Literature review on technology transfer within a Triple Helix framework **5**

1.1. Initial considerations 5

1.2. International Technology transfer within a triple helix framework 5

1.2.1. Conceptualizing technology transfer 5

1.2.2. The Triple Helix basic framework 9

1.2.3. University, Industry and Government: Towards hybridization 11

1.2.4. The emergency of trilateral networks and the skills brokerage model 14

1.3. Key factors of international technology transfer and main hypothesis to be tested 15

1.3.1. Human capital and absorptive capability 16

1.3.2. Connectedness and networking dynamics 17

1.3.3. Trust and common objectives 18

1.3.4. Prior experience in international or technological partnerships 19

1.3.5. Control Variables 20

Chapter 2. Methodological underpins **21**

2.1. Initial considerations 21

2.2. Enterprise Europe Network (EEN) as relevant basis of study 21

2.2.1. Genesis of EEN 21

2.2.2. Mission and activity of EEN 23

2.2.3. Institutional framework of EEN 24

2.2.4. Technology transfer within the EEN 24

2.3. The questionnaires implemented and the operationalisation of the relevant variables of the model 26

2.3.1. Successful international technology transfer 26

2.3.2. Human capital and Absorptive capability 29
2.3.5. Network connectedness 31
2.3.3. Trust 32
2.3.6. Prior experience with partnerships and international experience 33
2.3.7. Control variables: size and sector 34
2.4. The process of data gathering 34
Chapter 3. Determinants of International Technology Transfer. Empirical Results 39
3.1. Initial Considerations 39
3.2. Brief descriptive analyses 39
3.3. Key hypothesis of the 'theoretical' model 41
3.4. Determinants of ITT through the lens of EEN partner. Estimation results 42
Conclusions 47
References 50
Appendixes 55
Appendix 1 - Enterprise Europe Network's Sector groups 56
Appendix 2 – Questionnaire implemented to EEN partners 57
Appendix 3 – Questionnaire implemented to EEN clients 59

Index of Tables:

Table 1: Conceptualizing technology transfer 8

Table 2: Determinants of technology transfer within a Triple Helix relation 16

Table 3: EIP main instruments and how they contribute to achieve the objectives (EC-EIP, 2010) 22

Table 4: Determinants of transfer of technology and proxies 27

Table 5: Measure of successful international technology transfer between two EEN clients 29

Table 6: Measure to estimate the human capital and the absorptive capability of EEN partners and EEN clients 30

Table 7: Measure to estimate the network connectedness between EEN partners and clients 31

Table 8: Measure to estimate the trust relation between EEN partners and clients 32

Table 9: Measures for prior experience in technological and international partnership 33

Table 10: Results from the Kruskal-Wallis Test 40

Table 11: Hypotheses proposed 42

Table 12: Correlation analysis for international technology transfer measures on EEN partners[1] 44

Table 13: Regression models for international technology transfer on EEN partners 46

Index of Figures

Figure 1: The Triple Helix I (statist) and II (*laissez-faire*) models of university-industry-government relations 12

Figure 2: The Triple Helix III model of university-industry-government relations..... 12

Figure 3: Main services and instruments of Enterprise Europe Network 23

Figure 4: A typical support process in Enterprise Europe Network..... 25

Figure 5: Schematic overview of data gathering process..... 36

Introduction

During the last years the world moved towards a knowledge-based economy (Bommer et al., 1991; Bessant and Rush, 1993; Sung et al., 2003; Arvanitis and Woerter, 2009; Lai, 2011) on which knowledge and technology became the most important resource (Sung et al., 2003; Wang et al.., 2004; Arvanitis et al., 2005; Lee et al., 2007) to the endowment of companies and to the growth of industries (Bessant and Rush, 1993; Soete and Weel, 1999; Sung et al., 2003; Arvanitis et al., 2005; Laroche and Amara, 2011).

Studies conducted in sociology, economy and management confirmed the central role of technology in productivity change and economic development (Reddy and Zhao, 1990). Simultaneously, strategic theorists recommended a competitive strategy based on the rising of technology as a competitive force (Reddy and Zhao, 1990).

The intensive global competition and the fast technological development (Santoro and Gopalakrishnan, 2000) create new challenges to organizations and more often they are lacking of resources and time to keep the leading edge (Sherwood and Covin, 2008) which impels them to go outside their boundaries and look for external sources of knowledge (Bessant and Rush, 1993; Zahra and Nielsen, 2002; Gopalakrishnan and Santoro, 2004; Sherwood and Covin, 2008; Arvanitis and Woerter, 2009).

This new technological settings brought up new linkages between industry (suppliers, customers, competitors) and public organizations like research institutions (Arvanitis and Woerter, 2009) and universities (Santoro and Bierly, 2006; Sherwood and Covin, 2008; Lai, 2011). Universities realized the commercial value of their researches and they are now focused on the ‘capitalization of knowledge’ (Etzkowitz, 1998). Likewise, industry recognized the positive impact of the knowledge produced in the university (Laroche and Amara, 2011) in their innovation and economic performance (Arvanitis and Woerter, 2009).

Increasingly, science and business institutions espouse strategies in order to improve their performance through cooperation with other organizations (Arvanitis and Woerter, 2009; Teixeira and Mota, 2012). In such scenario, technology transfer is of major importance (Arvanitis and Woerter, 2009; Duan et al.., 2010; Lai, 2011). The process from which technology is acquired from external sources has drawn the attention of a large number of researchers during the last years (Bessant and Rush, 1993).

Beyond its impact in the endowment of firms and in industry, technology is also a critical element for the sustainability and economic growth of countries (Bessant and Rush, 1993; Arvanitis et al., 2005; Lai, 2011) and has become a key point in their policy agenda (Arvanitis et al., 2005). Empirical works support that the innovative performance can be positively affected by creating and maintaining the interaction between university-industry and the use of scientific knowledge (Debackere and Veugelers, 2005). The intensity of this relations and the learning process of producers, users, suppliers and public authorities can, indeed, influence the performance of a national economy (Debackere and Veugelers, 2005). With this in mind and with the aim to improve national competitiveness, governments are investing in the development of new technologies and improving the acts and regulations related with the university-industry collaboration (Lai, 2011). Notwithstanding, most countries find outside their boundaries the dominant source of technology which highlights the importance of international technology transfer (Keller, 2004).

The relation between university-industry had evolved along with the institutional relation between university-industry-government and with the innovation systems (Etzkowitz and Leydesdorff, 2000). Countries and regions, in order to develop this knowledge-based economy, are working towards a model of tri-lateral initiatives and strategic alliances, known as Triple Helix (Etzkowitz, 2003). The Triple Helix describes the relations between university, industry and government and the transformation and overlapping of each of the three spheres (Etzkowitz and Leydesdorff, 1995, 2000).

The impact on industry, economy and countries underlines the significance of technology transfer and the importance of uncovering which are the key-factors of its success and whether the new Triple Helix model is associated with them.

Several studies (e.g., Reddy and Zhao, 1990; Sung et al.., 2003; Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006) analyse the key factors of the technology transfer between university and industry (namely, absorptive capacity, human capital, trust, social connectedness, prior experience with partnerships, international experience) and the importance of intermediary organizations. However, such literature usually focuses on the technology transfer within a sector, region or country, neglecting the international dimension of technology transfer. Moreover, it is silent regarding the key factors that props up the activity of the technology transfer intermediaries at international level.

Thus, the present dissertation analyses the international technology transfer within a Triple Helix collaboration with the objective of understanding the key factors that boost the technology transfer in this context and outline characteristics of the entities involved in successful technology transference cases.

To achieve this objective, we conceptualize the Triple Helix matrix focusing on the European project Enterprise Europe Network (EEN). This network was created in 2008 under the Competitiveness and Innovation Framework Programme with the aim to promote the competitiveness and innovation at local level targeting small and medium enterprises (SME). With presence in more than 40 countries, the network is formed by approximately 600 partners' organizations with different key roles in their local communities.

This network represents a real case example of the Triple Helix framework in a international context: (1) cross-border cooperation is at the root of the network; (2) as a whole, partners cover the three spheres of the helix, universities, the private sector and public/governmental entities; (3) to achieve their goals they have to establish connections among them, which means that this network involves the creation of links between entities located in different countries and with different key roles.

The technology transfer in EEN is closely followed by the partners and can be traced by the partnership agreements (PA), a document signed by the EEN partners (e.g., Chambers of Commerce, Industry Associations, Technology Centres, Universities and Development Agencies) and the beneficiaries (which might be firms, universities and knowledge related organizations in general) involved in the transfer. Although PA involve other arrangements, commercial or research, due to the subject of this dissertation, only PA related with technology transfer are considered.

In methodological terms, we investigate the PA reported by the EEN partners during the last three years. Through direct questionnaires to EEN partners, we seek to comprehend their involvement as well as the key characteristic of the owner/ originator, intermediary and receptor of the technology. Additionally, through the analysis of the impact of the transfer of technology in the organization, we are able to identify the determinants of such transfer.

This dissertation is organized as follows. In Chapter 1 we provide a review of the literature regarding the technology transfer within a triple helix framework. Next, in

Chapter 2, the methodological approach and data gathering procedures are presented. The results are analysed and discussed in Chapter 3. Finally, in Conclusions we summarise the main results and put forward the main limitations and future paths for research.

Chapter 1. Literature review on technology transfer within a Triple Helix framework

1.1. Initial considerations

This chapter presents a literature review on technology transfer, its linkage with the Triple Helix framework and the factors that are considered to enhance the international transference of technology.

Firstly, we conceptualize the international technology transfer and present a basic framework of the Triple Helix. Based on the recent works of Etzkowitz and Leydesdorff (e.g. Etzkowitz and Leydesdorff, 1995; Etzkowitz and Leydesdorff, 2000; Leydesdorff 2000; Leydesdorff and Etzkowitz, 2001; Etzkowitz, 2003; Leydesdorff, 2011), the chapter follows with a comprehensive review on the linkages between university, industry and government and its impact on the emergence of this new innovation model. The Triple Helix model and the linkage with the skills brokerage model proposed by Papagiannidis and Li (2005) allows us to pool the importance of the trilateral network towards international technology transfer and therefore outline the key factors of international technology transfer and the main hypotheses to be tested.

1.2. International Technology transfer within a triple helix framework

1.2.1. Conceptualizing technology transfer

Differences in incomes across countries are not only explained by the physical and human capital but also by technology (Keller, 2001). In the growing knowledge-based economy, technology and its transfer is referred by numerous authors (e.g., Reddy and Zhao, 1990; Bessant and Rush, 1993; Soete and Weel, 1999; Sung et al., 2003; Wang et al., 2004; Arvanitis et al., 2005; Reisman, 2005; Lee et al., 2007; Laroche and Amara, 2011; Lai, 2011) as a critical factor of success for the economic development and competitiveness of an industry, region or country. The increasing of technology transference importance has aroused great interest among researchers and policy-makers (Bozeman, 2000) and, in the last decades, literature in the topic has begun to flourish with several authors proposing taxonomies and definitions (cf. Table 1). Nevertheless, this is a complex multidisciplinary concept and its definition is still amorphous (Soete and Weel, 1999).

Notwithstanding the existing vast literature, outlining technology transfer is considered by numerous authors as almost impossible (Bozeman, 2000; Zhao and Reisman, 1992) due to the awkwardness of defining 'technology', establishing boundaries in this dynamic process and measuring its impact in individuals, firms or countries.

To start, the definition of 'technology' is not clear (Bozeman, 2000). Technology was commonly seen as a tool (Bozeman, 2000). Sahal (1981, 1982, in Bozeman, 2000) describes technology as a 'configuration', stressing the idea that transfer of technology is not just about the product but also about its use and application. Hence and, following the theories of endogenous technical change that emerged in the beginning of the 90's, technology has seen as knowledge. In this vein, technology has three main characteristics (Keller, 2001): (1) it is a non-rival good meaning that the marginal cost for an additional user is insignificant; (2) return on investment for new technologies are both private (e.g. temporary monopoly) and public (benefits to external entities through knowledge base accumulation known as the knowledge spillovers); (3) technological change is the result of private agents efforts towards the creation of new products and processes (Keller, 2001). In a complementary point of view, Madeuf (1984: 126) identify technology "as a set of techniques, technology comprises information more or less formalized, written or not, resulting from application of scientific principles and/or from daily experience". Based on this definition, technology cannot exist or be transmitted without constraints and, being used by firms as information during its activities, technology is roughly appropriated and loses the theoretical characteristics of public good (Arrow, 1969, in Madeuf, 1984).

The parallel processes linking organizational and institutional interactions in a technology-related exchange (Roessner in Bozeman, 2000), are another issue that difficult the definition of technology transfer. According to Gibson and Smilor (1991: 289), to transfer technology "across different functions within a single product division of a single company" can be a difficult process, worsened by the fact that technology can be transferred between the universities, public research organizations and firms in various forms (Arvanitis and Woerter, 2009).

Finally, the impact on the organizations involved is difficult to measure (Bozeman, 2000). Technology transfer has also a multidisciplinary nature and it can occur in every field of knowledge transcending the boundaries of sectors and disciplines (Reisman, 2005). Economists, sociologists, anthropologists, engineers and management theorists

had contributed to the knowledge base of the topic but each of them with a role, definition and a taxonomy reflecting his perspectives which originates numerous definitions according with the discipline and the purpose of the research (Zhao and Reisman, 1992). Reddy and Zhao (1990) argue that works prior to 1990 failed to emphasize the international political dimensions, commercial transactions and operational matters, and did not considered the horizontal and vertical dimension of the transfer. [1] In fact, given the interdependency between horizontal and vertical components, the contribution of technology transfer can rarely be isolated (Reddy and Zhao, 1990).

In an international context, technology transference can flow through numerous channels (Glass and Saggi, 1999).

Categorizing the literature about technology, its process of transference and its international scope would be unfruitful (Bozeman, 2000) but general characteristics can be traced. In a simple definition, technology transfer can be described as the process through which organization acquired technology from an external source (Bessant and Rush, 1993; Cumming and Teng, 2003). The term "technology transfer" involves the complementarity between the technical performance to exploit new materials and to design and/or manufacture a new class of devices, products or equipment (Kohler et al., 1973) and between the know-how application, both belonging to a firm or to a country (Madeuf, 1984).

Another refereed aspects are the capability to transfer (Teece, 1977), the enhancement of the receptor (Arvanitis and Woerter, 2009) and the profitability and usefulness of the technology (Kohler et al., 1973). In an international perspective, these outlines describe the technology transfer as a process which allows the recipient country not only to use but also exploit the technology and endows the receptor country with capabilities and skills to use it and to learn the inherent techniques (Kohler et al., 1973).

[1] According with the authors, the three horizontal elements in ITT are the home country (where the technology is originates), the host country (the recipient) and the transaction. As the vertical elements, it was identified specific aspects which concern to the country, industry or firm.

Table 1: Conceptualizing technology transfer

Scope	Study	Aim of study	Definition	Key dimension
National	Gibson and Smilor (1991)	Understand technology transfer in an R&D consortium and its members companies	Movement of technology (knowledge, ideas or physical products) across some type of channel (person-to-person, person-to-person, group-to-group, or organization-to- organization)	Movement of knowledge, ideas or products
	Arvanitis and Woerter (2009)	Factors that encourage the Swiss science institutions to engage in knowledge and technology transfer along with private entities	Any transfer of knowledge and technology that enhance the activities of a company or university and/or research centre	Enhancement of the receptor
International	Kohler et al. (1973)	Study the source and receiver of technology transfer between German and American industrial firms	Processes by which a country reproduces or replicates, profitably or usefully, a technical performance that had been achieved by another country.	Profitability and usefulness
	Teece (1977)	Study the level and determinants of the cost involved in an international technology transfer process	Capability to transfer the manufacturing of a product or process between firms located in different countries	Capability to transfer
	Madeuf (1984)	Record and measure transfers of technology by technological balances of payments	Should concern to a process owned and used by a firm during its production activities, and the technology includes the technology process and the know-how application	Distinguish between technology transfer and technology flow
	Glass and Saggi (1999)	Oligopoly model with a multinational firm with a superior technology in a host country with the aim of determinate whether a technological transfer occur or not	Process by which a technical information is transfer from one party in one country to other party in a foreign country and the last one take it in into its products process Transference of knowledge and skills to the home country that had been acquire during a temporary movement of professionals or services suppliers in a developed country	Absorptive capability
	EC (2007: 6)	Alert researchers and business about the advantages of a close work in the R&D field	"Processes for capturing, collecting and sharing explicit and tacit knowledge, including skills and competence. It includes both commercial and non-commercial activities such as research collaborations, consultancy, licensing, spin-off creation, researcher mobility, publication, etc. While the emphasis is on scientific and technological knowledge other forms such as technology-enabled business processes are also concerned."	Explicit and tacit knowledge
	Edler et al. (2011:793)	Study the impact of temporary international mobility of scientists in their propensity to knowledge and technology transfer activities	"Knowledge and technology transfer in a broad understanding that refers to knowledge embodied in technological artefacts, codified and non-codified knowledge, as well as knowledge that is co-produced in various forms, e.g. in collaborative projects"	Knowledge embodied or not in an object/ technology

Although not being widely referred in the literature, in the context of this dissertation the distinction between technology transfer and technology flow proposed by Madeuf (1973) is of great relevance. Technological flows, such as consultancy services, are excluded of his definition of technology transfer, as they do not imply the transfer of a process owned and used by the supplier. Unless they are selling or leasing the knowledge to produce technical studies, consulting firms produce and sell technical services as an output. Within the context of the case study, the Enterprise Europe Network technological flows are not considered as technology transfer and for that reason they will not be object of study.

1.2.2. The Triple Helix basic framework

Etzkowitz and Leydesdorff (1995, 2000) conceptualized the Triple Helix model of relations between university, industry and government with the aim to explain the increasing interactions between these three spheres and the innovation strategies and practices that result from that cooperation (Etzkowitz, 2003).

According to Leydesdorff and Meyer (2003), besides the Triple Helix model, the Mode 2 (knowledge production) and Mode 1 (disciplinary knowledge production) distinction, and the National Systems of Innovation (NSI), in evolutionary economics, were also proposed to study the innovation system in a knowledge-based society. Nevertheless, their differences in conceptualizing the system integration and differentiation among spheres, led us to select Etzkowitz and Leydesdorff's model (1995, 2000) as the main theoretical approach of this dissertation.

Technological and academic knowledge has become a valuable resource in the economy as its application grew in the industrial production and social development (Leydesdorff and Etzkowitz, 2001). The competition for innovative products and cutting edge technologies transformed innovation from an internal process within individual companies to an external process embracing companies and universities (Santoro and Bierly, 2006), the traditional producers of knowledge (Etzkowitz, 2003). In this context, a new economic structure emerged based on the knowledge in which the university plays the most important role as a source of innovation (Leydesdorff, 2011).

In this knowledge-based economy, apart from the two sub dynamics prevailing in a political economy - market equilibrium and normative control mechanisms – the production of knowledge has to be considered as a third transformation dynamics

(Leydesdorff, 2011). The institutional infrastructure provided by a political economy is then its substitute by the complex dynamic of an economy based on knowledge built over communication flows through networks (Leydesdorff and Meyer, 2003). As result, the technological and social context of science originates a continuous transformation in the society structure (Leydesdorff, 2011) and the overlay of communication reshaped the relation between universities, industries and government (Etzkowitz and Leydesdorff, 2000).

The model proposed by Etzkowitz and Leydesdorff (1995, 2000) takes into consideration three main elements (Papagiannidis at al., 2009): (1) the prominent role of the university together with industry and government; (2) the interaction between university, industry and government as a key to innovation, and (3) the multiple functions of the three spheres.

Opposite to the National System of Innovation where the firm has the leading role in innovation (Meyer et al., 2003), playing university and government supporting roles (Etzkowitz, 2003), the Triple Helix promotes the importance of the university (Etzkowitz and Leydesdorff, 2000).

Another essential characteristic in the Triple Helix model is the interaction between university, industry and government (Etzkowitz, 2003). In a knowledge-based society, this interaction is the key to innovation (Etzkowitz, 2003). The innovation policy is no longer a prescription from the government but a result of the collaborative relation between the three spheres (Papagiannidis at al., 2009).

In addition to the increasing interaction between spheres, the Triple Helix model also postulates the internal transformation of the three dimensions (Leydesdorff and Etzkowitz, 2001). Beyond their traditional functions, each one of the helices can assume the role of the other (Leydesdorff and Etzkowitz, 2001) into a reciprocal relationship of performance increasing (Etzkowitz, 2003). Traditional models such as NSI define institutions according with their traditional functions (Etzkowitz, 2003) but, since the innovation process went out of the internal boundaries of companies involving universities and government (Sherwood and Covin, 2008), each sphere no longer plays only their traditional role but also new roles. Not surprisingly, concepts such as ‘academic entrepreneurs’ and ‘entrepreneurial university’ emerge (Meyer et al., 2003) stumbling the traditional boundaries between the three dimensions (Etzkowitz, 2003).

To sum up, the helices present an internal development while interacting in the goods and services exchanging and overlaying functions (Leydesdorff and Meyer, 2003).

1.2.3. University, Industry and Government: Towards hybridization

The Triple Helix model proposals by Etzkowitz and Leydesdorff (1995, 2000) capture the recent transformation of roles and interaction among the triad university- industry-government (Etzkowitz, 2003). Nonetheless, their paths began on the second half of the 19th century (Leydesdorff 2000) from two opposite models (cf. Figure 1): (1) a statistic model with government driving industry and academia; (2) and the *laissez-faire* model where the three spheres are separate with strong boundaries and interactions are few (Etzkowitz, 2003).

In Triple Helix I, the statist model, the government incorporates academia and industry and mediates the relations between them (Etzkowitz and Leydesdorff, 2000). This type of system is found in countries where the dominant institution is the government being industry and university are part of it (Etzkowitz, 2003). As an example, we could look at the 1970s and early 1980s Science & Technology policies that had had been undertaken by Brazilian government, which supported large-scale technology projects to leverage the universities research level and, consequently, stimulate new technology industries and affect the regional development (Etzkowitz, 2003). Other examples are the former Soviet Union and the Eastern European countries, and, its weaker version can be seen in some countries in Latin America and in some European countries such as Norway (Etzkowitz and Leydesdorff, 2000). Key features of this version are the university function, as a source of qualified human resources, and the separation between the local technology industry and the rest of the world (Etzkowitz, 2003).

The *laissez-faire* Triple Helix separates the institutional spheres creating strong boundaries between them (Etzkowitz and Leydesdorff, 2000). In this version it is expected institutions to compete among them rather than to cooperate (Etzkowitz, 2003). The communication between university, government and industry is limited and, when happening, it is usually through intermediaries (Etzkowitz, 2003). The leading role of the regime belongs to the industry, being the function of university the provision of knowledge through basic research and graduates (Etzkowitz, 2003). The intervention of the government in the industry is limited to regulation and public procurement (Etzkowitz, 2003).

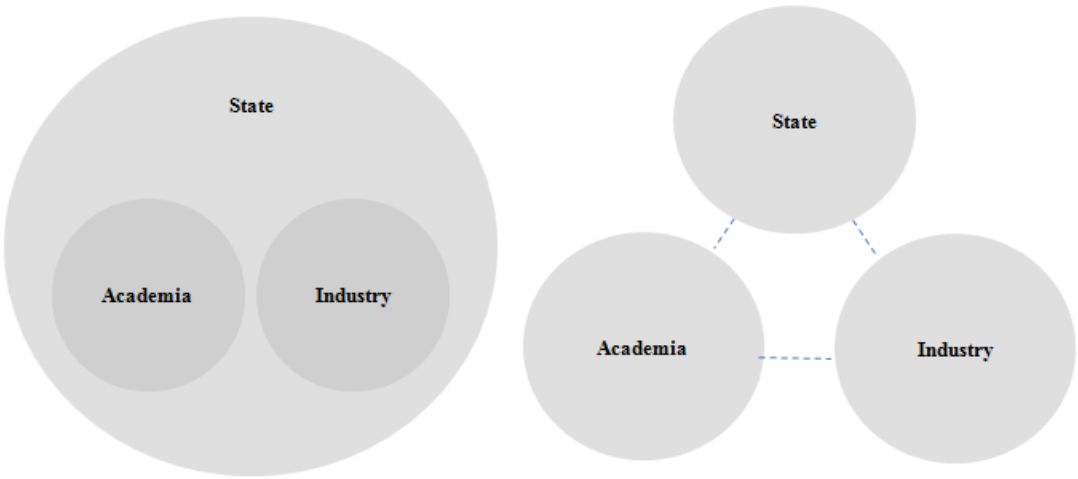

Figure 1: The Triple Helix I (statist) and II (*laissez-faire*) models of university-industry-government relations
Source: Adapted from Etzkowitz and Leydesdorff (2000)

Whether a country started from a statist or a *laissez-faire* model, a new global movement of knowledge and technology management is emerging (Etzkowitz, 2003) on which the Triple Helix converges into a knowledge infrastructure where the three dimensions compete simultaneously and cooperate (Etzkowitz and Leydesdorff, 2000), maintaining their traditional roles but also playing the role of the other (Etzkowitz, 2003).

The overlap of spheres and roles is the basis of the emergence of hybrid organizations and trilateral networks (Etzkowitz and Leydesdorff, 2000).

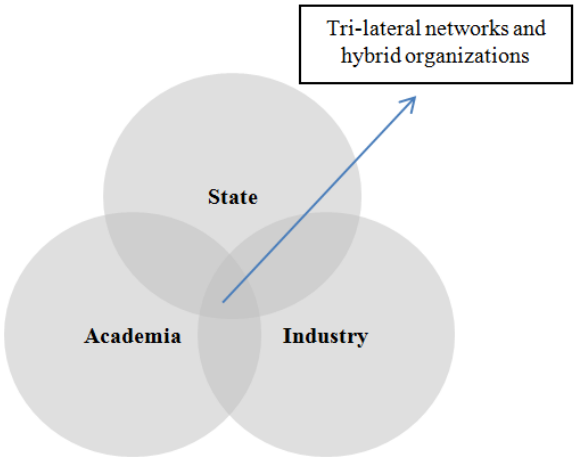

Figure 2: The Triple Helix III model of university-industry-government relations
Source. Adapted from Etzkowitz and Leydesdorff (2000)

As the interactions between the three dimensions are in the basis of economic development in a knowledge society, regions and countries are working towards this last form of the Triple Helix (Etzkowitz and Leydesdorff, 2000). Such transformation can be seen in the industry with the creation of start-ups and universities' spin-offs, and with the large firm investments in the development of incubation facilities, with the aim to develop new business models and to promote the post-doctoral researcher (Etzkowitz, 2003).

Also, at the policy level, differences can be pointed. Government lost its central function, although it still has an important role in the Triple Helix, providing incentives to promote the innovation (Leydesdorff and Etzkowitz, 2001). Its role is now develop funding programs (Santoro and Bierly, 2006) and providing tax incentives that incentivize the cooperation between industry and universities, and provide legal frameworks (Leydesdorff and Etzkowitz, 2001; Papagiannidis et al., 2009).

However, the major transformation occurred in the university sphere (Etzkowitz and Leydesdorff, 2000). Building upon its previous role as innovation support (Etzkowitz, 2003), providing trained persons and basic knowledge, the university is now a source of economic and social development (Leydesdorff and Etzkowitz, 2001), emerging as a prominent player among the Triple Helix (Etzkowitz, 2003). The relation between university and industry is evolving over the last years (Santoro and Bierly, 2006). Nowadays, universities are more aware of the economic value the knowledge they produce and researchers are more interested in product commercialization (Santoro and Bierly, 2006). As a consequence, the new relation does not involve consultation fees or donations, but the participation in companies and real estate development (Etzkowitz, 1998). This transaction is revered by Etzkowitz (1998) as 'capitalization of knowledge'. From the standpoint of several authors (e.g. Etzkowitz, 1998; Santoro and Bierly, 2006), this can be considered as an university 'third mission', and its addition to the first and second missions – teaching and research - a 'second revolution' in the academy is predictable (Etzkowitz, 1998).

In short, the economic and social development is now motivated by an innovation model that undermines the triad university-industry-government driving them into a knowledge infrastructure explained by the autonomy but also by the interdependence between spheres (Leydesdorff and Etzkowitz, 2001).

Nevertheless, the hybridization among the triad is not only reflected in the transformation of institutional boundaries but also in the redesigning of the national boundaries (Leydesdorff and Etzkowitz, 2001). With economies and markets internationally connected, organizations assume a global posture and also the governments actuation goes beyond the local and national boundaries and act at international level (Etzkowitz and Leydesdorff, 2000; Leydesdorff and Meyer, 2003).

1.2.4. The emergency of trilateral networks and the skills brokerage model

The new innovation model emerged from the Triple Helix assumes the theoretical and practical integration of resources among university, industry and government to promote the economic development (Papagiannidis et al., 2009). The integration among the three helices created tri-lateral networks and hybrid organizations (Etzkowitz and Leydesdorff, 2000).

In this context, Etzkowitz and Leydesdorff (2001) refer the emergence of the knowledge brokers, which act as network coordinators and organizers with the task of link people from different spheres. This innovation professionals move up in a complex system of overlay networks and its interorganizational and interpersonal skills increasingly empower this emergence of interface organizations (Etzkowitz and Leydesdorff, 2000).

Also Papagiannidis and Li (2005) presented the skills brokerage business model that was later linked to Triple Helix model. Together they explain the triad transformation towards innovation and the emergence of hybrid entities (Papagiannidis et al., 2009).

The skills brokerage business model of Papagiannidis and Li (2005) explain the emergence of new entities that moves among the three helices. This new and young companies support start-ups and established business in a networked economy: “In the skills brokerage business model, an entrepreneur or an established company exchanges skills; resources; access to networks and, more generally, other forms of human and social capital with a skills provider, who in exchange receives equity or direct access to the venture’s returns or a combination of both” (Papagiannidis et al., 2009: 219). The skills brokerage act as a facilitator between the market actors forming a link between them with the aim of encompass the lack of skills and costs, identify as the two main challenges of the entrepreneurs (Papagiannidis and Li, 2005).

Not directly related with Triple Helix but important in the context of the present dissertation, stands the focus on specialized skills in the brokerage model. Papagiannidis

and Li (2005) refer that generally support services are focus on a broad range of skills and services, nevertheless specialized services are thought to be more beneficial to entrepreneurs. In a reference to the research of Davidsson and Honig (2003), the authors take into account the need of national and regional governments in considering the creation of communities and networking activities that focus on individual business needs rather than in generic activities.

1.3. Key factors of international technology transfer and main hypothesis to be tested

Existing literature on technology transfer tend to focus in university-industry relation and the role of technology transfer offices. The role of hybrid organizations that moves between university, industry and government is still little debated in literature.

The choice of determinants to study was guided by previous empirical studies on university-industry technology transferences, and also based on theorical literature on the Triple Helix model and the role of intermediaries in the transfer process.

The technology transfer process tend to be stimulated if certain key facilitators – e.g., social connectedness, trust, prior experience - are present (Santoro and Bierly, 2006). These facilitators are deeply related with: (1) hybrid organizations characteristics (2) client's characteristics and (3) relation between the hybrid organizations and its clients within a technology transfer process.

Among the many determinants of technology transfer proposed, same stand out (cf. Table 2): absorptive capacity, human capital, trust, social connectedness, prior experience with partnerships, international experience.

Within a triple helix framework, technology transfer depends of industry characteristics, EEN characteristics and from the industry perception of EEN.

Table 2: Determinants of technology transfer within a Triple Helix relation

Key dimension	Main determinants	Author (year)
Human capital	Technical capabilities	Succar (1987)
	Training	Reddy and Zhao (1990)
	Human Capital	Kneller (2010); Keller (2004);
Absorptive capability	Absorptive capability	Reddy and Zhao (1990); Cohen and Levinthen (1990) ; Gibson and Smilor (1991); Keller (2001); Gopalakrishnan and Santoro (2004); Santoro and Bierly (2006); Arvanitis and Woerter (2009) Kneller et al. (2010)
Connectedness	Relationship	Reddy and Zhao (1990)
	Communication	Gibson and Smilor (1995); Gopalakrishnan and Santoro, (2004)
	Social connectedness	Santoro and Bierly (2006)
Trust	Trust	Gopalakrishnan and Santoro (2004);Santoro and Bierly (2006); Sherwood and Covin (2008)
Prior experience with partnerships	Prior Experience	Santoro and Bierly (2006)
	Alliance experience	Sherwood and Covin (2008)
	Number of partners	Arvanitis and Woerter (2009)
	Experience in foreign countries	Reddy and Zhao (1990)
	Existence of contacts to foreign universities	Arvanitis and Woerter (2009)
Size	Firm Size	Gopalakrishnan and Santoro(2004); Santoro and Bierly (2006)
Sector	Sector	Santoro and Bierly (2006)

1.3.1. Human capital and absorptive capability

The determinants of a successful transference of technology are deeply related with the actors involved, in fact, they can be drivers or barriers (Duan et al., 2010). In a transfer process the capability of absorb and re-use that technology can either enhance or undermine the successfulness of the transfer (Duan et al., 2010).

According with the empirical evidence, the adoption of a technology can be facilitated by certain skills rooted in the human capital of a closed economy or a country promoting the acceptance of new or external technologies (Keller, 2004). In other words, human capital facilitates the technology transfer between and beyond national boundaries (Keller, 2004; Kneller et al., 2010).

Since the EEN highlight the importance of their human resources, we believe that the skills of the EEN consultants are determinant during an international technology transfer.

H1: International technology transfer depends directly on organizations' human capital endowment.

Human capital is frequently included in the absorptive capability (Kneller et al., 2010). Although the term absorptive capability has been presented by Cohen and Levinthen (1990), the idea was before referred by Madeuf (1983). In his work about international technology transfer and international technology payments, the author state that a transfer can only be successful when the recipient, by itself, is able to use, reproduce and even improve the technology transfer. Cohen and Levinthen (1990) introduce the term absorptive capability as the ability to recognize the value of new external information and successfully adopt, assimilate and exploit it. It can be applied not only to companies but also to countries (Keller, 2001) and, in equal circumstances of access, determinates the ability of a company or country to benefit from the technology (Kneller et al., 2010). Not surprisingly, the absorptive capability is referred by several authors as a key determinant in transference of technology (Cohen and Levinthen, 1990; Keller, 2001; Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006; Kneller et al., 2010).

Despite the main studies focus on the relation between the technology transfer and capabilities between the actors involved in a two spheres perspective, it is expectable the same connection between the actors of the Triple Helix. In the context of your analysis, absorptive capability will not only determinate the capacity of a EEN partner to identify the value of a technological cooperation for its clients but also the capacity of its clients to internalize external knowledge and take advantage of it. Therefore, it is expected that the successful technology transfer mediated by the EEN depends on the absorptive capacity of the stakeholders.

H2: The success of an international technology transfer involving a technology broker depends directly on the absorptive capacity of the stakeholders.

1.3.2. Connectedness and networking dynamics

Also related with the technology transfers actors, and as important as the absorptive capability, is the connectedness between the partners. According with several authors (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006; Duan et al., 2010; Laroche and Amara, 2011), the connectedness between partners plays a crucial role in the transference of technology.

Environments that foster interpersonal relationships can be conducts of knowledge flow (Santoro and Bierly, 2006) since acquaintances facilitate the working arrangement

between partners (Duan et al., 2010). Sherwood and Covin (2008) affirmed that familiarity with partners can foster routines of knowledge-sharing which leads to the mutual understanding of procedures and practices and consequently promote the acquisition of technology.

This strength of innovativeness capabilities was also referred as technological relatedness by Santoro and Bierly (2006). Due to limited resources and expertise, companies frequently collaborate with university research centres with the aim of access new technologies (Santoro and Bierly, 2006). The overlap between the knowledge access and the strength of the technological base is, accordingly with the authors, one of the facilitators of knowledge transfer.

Similarly, it is expected that the same connectedness between the actions from the Triple Helix. Indeed, Gkikas (2011) refers the importance of the networking to the innovativeness of a firm. He concludes, based in his research on other studies, that the innovativeness of a firm is positively correlated with collaboration with other entities, more specifically between the Triple Helix actors.

H3: International technology transfer is facilitated if network connectedness is encouraged.

1.3.3. Trust and common objectives

Trust is one of the most important elements in an inter-organizational partnership (Santoro and Bierly, 2006) and a determinant for its success (Sherwood and Covin, 2008). Existing not only between individuals, but also between organizations (Sherwood and Covin, 2008), trust can be describe as mutual confidence that the other part will act in compatible interests rather than opportunistically (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006).

Sherwood and Covin (2008) confirmed in their study that the success of the knowledge acquisition in university-industry alliances depends on routines of knowledge sharing built on legitimate trust between the sending and the receiving partner.

In an organizational approach, apart from the organization history and culture, Gopalakrishnan and Santoro (2004) also related the likelihood of establish trust relationships between a company and the university partner with their shared values. According with the authors, there will be a propensity to a company trust in a university

partner if they believe that their strategic objectives will be better achieve with integration of the expertise of the university partner. In fact, the company willingness to trust relies on its belief on the university partner expertise and in its availability to share it and to jointly accomplish the companies' objectives (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006).

Aside from that, when trust is built between a company and a university partner, confidence about abilities and behaviour also increase as well as the willing of sharing ideas and goals (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006).

As well as enable open communication and knowledge transfer between companies and university research centres (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006), and receiving and sending organizations (Sherwood and Covin, 2008) the same is expected between the units of analysis of this dissertation. Trust between a hybrid organization and its clients is expected to foster the success of the international technology transfer.

H4: International technology transfer success is positively related with the trust relation between the technology sender/ recipient and the trilateral network.

1.3.4. Prior experience in international or technological partnerships

Prior experience in partnerships can be critical in technology transfer (Santoro and Bierly, 2006; Sherwood and Covin, 2008; Arvanitis and Woerter, 2009). Similarly, companies with international experience have more probability of effectively transfer technology at international level (Reddy and Zhao, 1990).

Companies with prior experience in partnerships learn from their past success and failures, building relevant knowledge that allows them to understand quicker collaboration opportunities, to appropriate manage the alliance and to beneficiate from it (Santoro and Bierly, 2006; Sherwood and Covin, 2008; Arvanitis and Woerter, 2009). So that, prior experience can suggests a propensity to celebrate successful alliances, including partnerships for the transference of technology (Santoro and Bierly, 2006).

From the university-industry collaboration perspective, the company's prior experience in working with a university can be determinant in a process of technology transfer (Santoro and Bierly, 2006).

H5: International technology transfer depends on the prior experience of the organization in international or technological partnerships.

1.3.5. Control Variables

Size

There are different conclusions regarding the influence of an organization size in technology transfer activities (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006). Prior studies indicate that size can be relevant in collaboration between industry and university (Santoro and Bierly 2006) as it defines the partner interface mechanisms (Sherwood and Covin, 2008). The inclusion of this variable can help us to understand if technology transfer success is related with the dimension of hybrid organizations or/and with the dimension of the companies that appeal to services.

Sector

Previous works conclude that university-industry relationships is highly sector specific (Santoro and Bierly, 2006). We would like to know if in technology transfer between the triad relations is more common in one sector than in another.

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Based on the importance of the facilitators describe above for the technology transfer between university-industry at a national level, it is expected that the same facilitators can leverage the transfer at an international level within the Enterprise Europe Network context.

Chapter 2. Methodological underpins

2.1. Initial considerations

The research objective of the dissertation is to study the key factors that facilitate the international technology transfer within the context of Triple Helix relationships. While the literature tend to concentrate in the university-industry relation, we go further with the attempt of operationalise the university-industry-government relation established in an international technology transfer context.

Thus, the present dissertation seeks to analyze the key factors that boost the international technology transfer within a Triple Helix collaboration and outline characteristics of the entities involved in successful technology transference cases. Furthermore, it contributes to the literature on international technology transfer by analyzing the international technology transfer within the Triple Helix framework.

After a comprehensive review of the literature that identified the key factors for (international) transfer technology in various environments and relevant for the study (Section 3), we realize that for answering the main research question we need to gather information from two sources: (1) EEN partners that reported technological partnership agreements between their clients in the last three years [2] and (2) clients who were involved in a technology transfer promoted by an EEN partner.

In what follows, we briefly describe the Enterprise Europe Network (EEN) (Section 2.2), the questionnaires implemented and the operationalisation of the relevant variable of the model (Section 2.3), and the process of data gathering (Section 2.4).

2.2. Enterprise Europe Network (EEN) as relevant basis of study

2.2.1. Genesis of EEN

The European project *Enterprise Europe Network* (EEN) was selected as the empirical basis of the research framework. This is because (1) cross-border cooperation is at the root of the network; (2) as a whole, partners cover the three spheres of the helix, universities, the private sector and public/governmental entities; (3) to achieve their goals partners have to establish connections among them, which means that this

[2] EEN was created in 2008 having three years of activity.

network involves the creation of links between entities located in different countries and with different key roles.

The *Enterprise Europe Network* (EEN) is part of the Competitiveness and Innovation Framework Programme (CIP), which is a program from the European Commission to foster the competitiveness of the European companies through innovation and eco-innovation activities (EC-CIP, 2008) and to facilitate the access to finance and provide business support services at regional level. The objectives of CIP are pursued through three specific programmes: Intelligent Energy-Europe Programme; Information and Communication Technology Policy Support Programme and the Entrepreneurship and Innovation Programme (EIP) (EC-CIP, 2008), the last one with special focus on competitiveness, innovation and entrepreneurial culture (EC-EIP, 2010).

As a program targeted to small and medium sized enterprises (SMEs) and responsible for defining conditions for growth (EC-EIP, 2010), EIP has four main instruments for accomplish its objectives, being the Enterprise Europe Network one of them (cf. Table 3).

Table 3: EIP main instruments and how they contribute to achieve the objectives (EC-EIP, 2010)

Entrepreneurship and Innovation Programme (EIP)	
Instrument	**Objectives**
1 - Financial instruments for SMEs	- access to finance for the start-up and growth of SMEs and investment in innovation activities; including eco-innovation;
2 - Services in support of business and innovation: **The Enterprise Europe Network**	- the creation of an **environment favourable to SME cooperation**, particularly in the field of **cross-border cooperation**;
3 - Innovation and eco-innovation first application and market replication projects	- all forms of innovation in enterprises; - eco-innovation; - entrepreneurship and innovation culture;
4 - Policy analyses, development, coordination and twinning	- the creation of an environment favourable to SME cooperation, particularly in the field of cross-border cooperation; - entrepreneurship and innovation culture - enterprise and innovation-related economic and administrative reform;

Source: Adapted from EC-EIP, 2010

EEN is the second main instrument of EIP and plays an important role in the pursuing of the objective of foster an "environment favourable to SME cooperation, particularly in the field of cross-border cooperation" (EC-EIP, 2010).

Building on Euro Info Centres and Innovation Relay Centres, the network was launch at 1 January 2008 with approximately 567 partners organizations located in 44 countries including EU 17 and neighbouring countries (EC- CIP, 2008).

2.2.2. Mission and activity of EEN

The mission of Enterprise Europe Network is to facilitate the access of small and medium companies to the EU Single Market supporting business and innovation at local level (EC-EIP, 2010). According with the operational objectives presented by Entrepreneurship and Innovation Programme (EC-EIP, 2007), the EEN is built up under an integrated service range that combines the support to enterprises towards their business development in foreign countries with services of technology and knowledge transfer. Synergies among network partners are encourage in order guiding the client to the most appropriate service provider, in a "no wrong door" philosophy. Following the same line, synergies with other local service providers are also promoted to offer complementary services (EC-EIP, 2010). EEN partners are also responsible for inform about EU programs and policies as well as encourage SMEs participation in the Community Framework Programme for research and technological development activities (EC-EIP, 2010). Inside the network, partners are committed to the continuously improvement of the services provided, to the local diffusion of the network ensuring the recognition and awareness of its services in the geographical areas covered (EC-EIP, 2010).

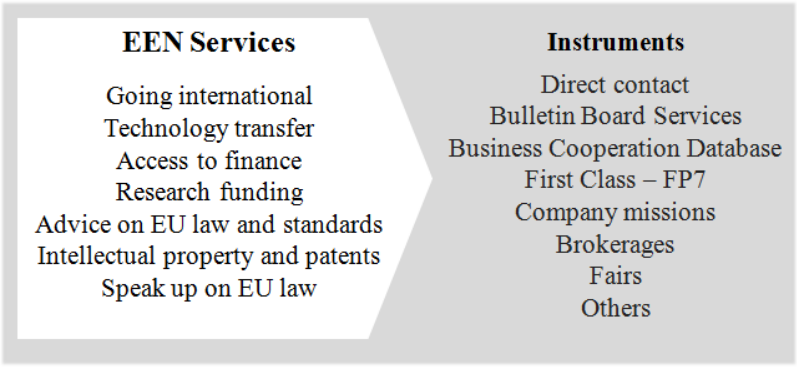

Figure 3: Main services and instruments of Enterprise Europe Network
Source: own elaboration

2.2.3. Institutional framework of EEN

Nowadays the network has 589 member organizations in 49 European and neighboring countries.[3] Beyond the EU 27 countries, the network extend its coverage to European Economic Area countries and other economic areas such as United States of America, Russia, South Korea, Japan and China (EC-CIP, 2010).

The partners are connected by databases and communication tools and have been working together for several years[4] in the previous network Euro Info Centres and Innovation Relay Centres. The network is organized through consortiums of members representing a country or a region. The members are in general chambers of commerce and industry, technology centre, universities and development agencies (EC-CIP, 2010) well recognized by their work with the local business sector.[5] At the same time, members organize themselves in *working groups* to discuss and work about specific matters concerning the network and in *sector groups* to provide a more customised support to clients. Additionally, *training actions* are locally organized with the aim to disseminate through the network the knowledge acquires by a partner in a specific subject. For members, these activities are not exclusive, on the contrary; they are complementary and enrich the service they provide. In accordance with that, the proximity with local business and network connection between partners are the key elements that permit EEN providing its business support and technology transfer services over Europe and beyond.

2.2.4. Technology transfer within the EEN

EEN provides integrated services towards business development and technology transfer (EC-EIP, 2010) to companies with strategic objectives of finding international business and/or technological partners.

Concerning technology transfer, it is important to refer that the EEN services are extended to universities and other researcher centres with interest in establish a technological partnership whether for development or commercialization.

A typical support of technology transfer in the EEN is similar to the process exemplify in the Figure 4. The client (as mentioned, a company, university and other researcher

[3] In: http://www.enterprise-europe-network.ec.europa.eu/about/mission, accessed in 31 January 2012.
[4] In: http://www.enterprise-europe-network.ec.europa.eu/about/mission, accessed in 31 January 2012.
[5] In: http://www.adeuropa.org/informacion/een/newsletter/ mar11/anexos/NetWorth_BrochureA4 _1_2010.pdf, accessed in 31 January 2012.

centre) with a technological offer or request contacts the local EEN partner, which will meet him. According with the strategy outlined by the organization and the objectives traced during the meeting, the best set of instruments will be use to find the right partner. Once found, a Partnership Agreement (PA) is sign by the organizations involved and the EEN partners.

The Partnership Agreement (PA) is an internal document with reference to the technology transferred, the organizations ('Client') and EEN partners involved. The technology transfer within the EEN might involve three sets of flows (between EEN's clients – bold arrow in the Figure 4):

- transfer between two companies.
- transfer between a company and a university/ research center.
- transfer between two universities/ research center.

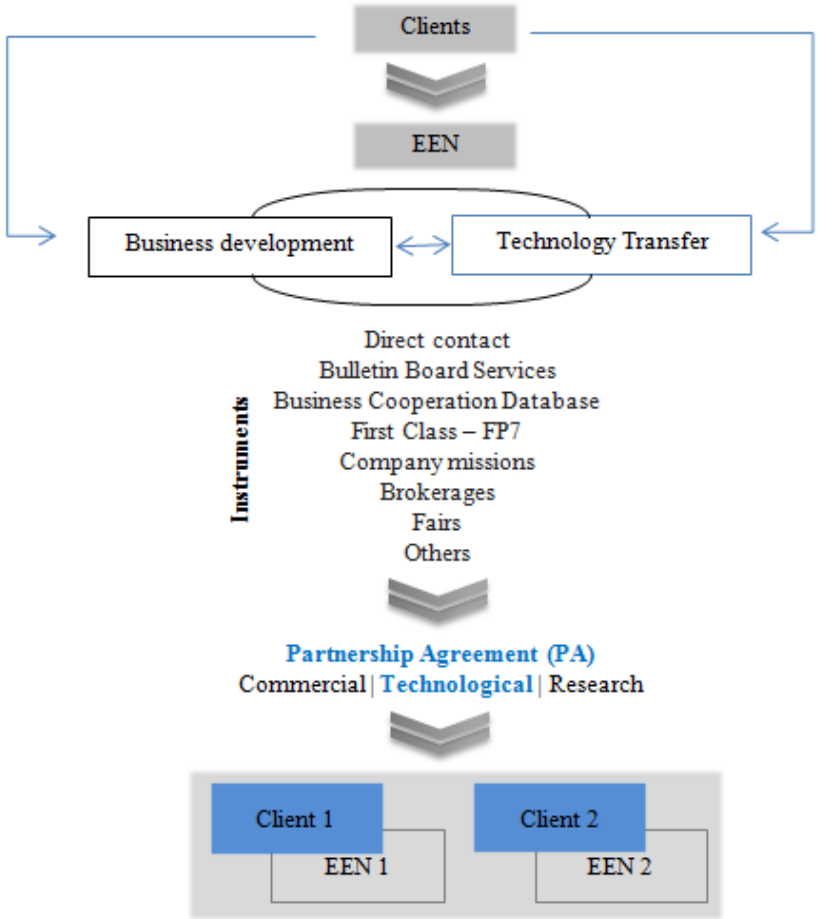

Figure 4: A typical support process in Enterprise Europe Network
Source: own elaboration

2.3. The questionnaires implemented and the operationalisation of the relevant variables of the model

The determinants studied under this research are briefly discussed in this section. The operationalization of the relevant variables was guided by the literature review on university-industry partnerships and technology transfer activities. The summary of the determinants of transfer of technology proposed by different studies are describe in Table 4, as well as the proxies used.

The questionnaire to EEN partners has three groups of questions on general information, activities and technological partnership agreements (cf. Appendix 2). The questionnaire to EEN's clients was formed by four parts on general information, relationship with EEN, relationship within the Triple Helix and technological partnership agreements (cf. Appendix 3). The questionnaires were personalized, and each Partnership Agreement (PA) was treated separately, so that, the respondents receive a questionnaire in which one group was related to each PA they were involved.

2.3.1. Successful international technology transfer

Transfer technology between international partners is the depend variable of this study. The transference of technology is not just the flow between a sending and a receiving company. Its success depends on the effectiveness and control of the recipient to use, reproduce and even improve the technology (Madeuf, 1983). Although various approaches were used (Cumming and Teng, 2003) in the attempt to define successful transfer as a variable, we will follow the point of view of Madeuf (1983) and state that the impact in the recipient organization determinate the successfulness of the technology transfer.

With that in mind, we adapted Santoro and Bierly's (2006) measure of knowledge transference from the university research center to companies. To measure the successfulness of the international technology transfer we adopted the seven-point Likert-type scale (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree) and inquiry the EEN clients (that is, firms, universities or research centres) about the value and utility of the technology transfer to the organization.

Table 4: Determinants of transfer of technology and proxies

Determinants	Proxy	Variables	Impact in TT	National/ International TT	Sample	Study
Absorptive capability	Absorptive capability	Frequency of R&D activities	-/0	National level	Industry- Public research institutions	Arvanitis and Woerter (2009)
		Share of employees with a tertiary education on total employees (in full-time equivalents)	+			
	Absorptive capability	Investment in R&D	0	Internacional level	Country and firm access to foreign technology	Kneller et al. (2010)
		Provision of formal training	0			
		Workforce education	0			
	Absorptive capability	R&D intensity (R&D investment divided by the firm's sales revenues)	+	National level	Industry- URC	Santoro and Bierly (2006)
Network connectedeness	Networking dynamics	Importance of universities and HEIs in accessing knowledge	-	Regional level	Triple Helix collaboration	Gkikas, 2011
		Importance of government in accessing knowledge	-			
		Importance of universities and HEIs in building innovation	-			
		Importance of government in building innovation	-			
		Importance of government in commercializing innovation				
	Social connectedness	Number of contacts with universities	+	National level	Industry- Public research institutions	Arvanitis and Woerter (2009)
		Knowledge and technology transfer with foreign universities	+			
		Sum of the scores for the individual evaluation of the importance of mediating institutions[1]	+			
	Social connectedness	Evaluation of closeness of the interactions at individual level of the partnership	+	National level	Industry- URC	Santoro and Bierly (2006)
	Social relation	Intensity of linkages with managers an/ or professionals from five types of organizations	+	National level	Transfer activities among Canadian researchers in occupational safety and health	Laroche and Amara (2011)
	Technological relatedness	Impact of accessing the URC expertise		National level	Industry- URC	Santoro and Bierly (2006)
		Impact of accessing the URC contact network				

Notes: [1] Mediating institutions: Technology Transfer offices, CTI (Innovation Promotion Agency), SNF/SNFS (Swiss National Science Foundation), EU Framework Programmes, Other European Programmes
Legend: + Positively related; (-) negatively related; (0) no significant

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Determinants	Proxy	Variables	Impact in TT	National/ International TT	Sample	Study
Trust	Trust	Willing to share ideas, feelings and goals with the university center	+	National level	Industry- URC	Gopalakrishnan and Santoro, 2004
		Confidence in the centre's competence and abilities, and in its motives and fairness in sharing these abilities	+			
		Sharing of a set of principles that the company finds acceptable	+			
	Trust	Firm willingness in sharing concerns and problems with the URC	+	National level	Industry- URC	Santoro and Bierly (2006)
		Firm awareness in URC capability in understand their needs	+			
		Firm willingness in sharing confidences with the URC	+			
		Sharing of common business values	+			
	Trust	Willing to share ideas, feelings and goals with the university center	+	Nacional level	Institualization of knowledge transfer within Univeristy-Industry	Santoro and Gopalakrishnan, 2000
		Confidence in the centre's competence and abilities, and in its motives and fairness in sharing these abilities	+			
		Sharing of a set of principles that the company finds acceptable	+			
Prior experience	Prior experience with partnerships	Relationships between the company and the URC prior to the partnership	Control variable	National level	Industry- URC	Santoro and Bierly (2006)
	Prior experience with partnerships	Number of prior technology transfer agreements with the universities	-	National level	University-Industry	Sherwood and Covin (2008)
Size	Size	Number of employees	Control variable	National level	Industry- URC	Santoro and Bierly (2006)
	Size	Number of employees	+	National level	Industry- URC	Gopalakrishnan and Santoro (2004)[2]
	Sector	High tech and capital intense[3]	Control variable	National level	Industry- URC	Santoro and Bierly (2006)

Notes: [2] The authors use the 7-S Framework as a teorical ground to identify organizational characteristics that may influence the technology transfer activity. The 7-S Framework is a model of organizational effectiveness Developed by Tom Peters and Robert Waterman. The model is based on the assumption that for an organization to be successful, seven internal factors must be aligned (strategy, structure, systems, shared values, skills, style and staff); [3] High tech (biotechnology, electronics, pharmaceuticals, optical equipment, medical laboratories, and research and development services) and capital intense (primary metals, fabricated metal products, industrial machinery, plastic molding, and ceramics).
Legend: + Positively related; (-) negatively related; (0) no significant

Depending on the function in the transfer, sender or receiver, we asked to evaluate, the degree of learning, assimilation and results occur from the concerned PA (Table 5).

As referred before, within the EEN, only technological transference between international partners can be reported as a partnership agreement. Therefore, the PA in this study is, by definition, international.

Table 5: Measure of successful international technology transfer between two EEN clients

Proxies:	**Source**
Successful international technology transfer (average score of the following items):	
Sending organization:	
We learn a great deal from the company involved.	Santoro and Bierly (2006)
The technology held by my organization was assimilated by the other partner and contributed to development of products/services.	
The technology held by my organization directly resulted in new products and services offered to the other partner customers.	
Recipient organization :	
We learn a great deal from the company involved.	Santoro and Bierly (2006)
The technology held by the other partner was assimilated by us and contributed to development of products/services.	
The technology held by the other partner directly resulted in new products and services offered to our customers.	

2.3.2. Human capital and Absorptive capability

R&D activities, *workforce education* and *training* are point out by numerous authors as the main indicators of the firm absorptive capability (Santoro and Bierly, 2006; Arvanitis and Woerter, 2009; Kneller et al., 2010). As we can see in Table 4, although the authors are consensual about the importance of R&D, workforce and training, there is not uniformity among authors regarding the proxies to be used as reflecting the absorptive capacity of an organization. Education achievement of organisations' labour force (Arvanitis and Woerter, 2009), R&D intensity (Kneller et al., 2010) or training are some of the different proxies used to analyze the absorptive capacity of an organization.

Due the importance of capabilities and skills of the EEN consultants in the network strategy and activity (EC-EIP, 2010), we compute the proxy for absorptive capability of the EEN partners based on the education level of the consultancy staff and by the average of the EEN budget invested in training activities in technology related fields (Table 6 - EEN Partners). In the same way, the absorptive capability of the EEN clients

is measure by the education level of the employees involved in ITT and the average of the turnover invested in training activities in technology related fields. Additionally to these proxies, we follow Cohen and Levinthal's (1990) study, and measure the R&D intensity of a firm by its share of investment on company's sales revenue (Tables 6 - EEN Clients). This measure helps us to understand the client's technological capability and therefore its capacity of transfer technology.

Table 6: Measure to estimate the human capital and the absorptive capability of EEN partners and EEN clients

Proxies:	**Source**
Human capital of EEN partners	
% of EEN staff involved in ITT	
Human capital of EEN partners	
% of EEN staff involved in ITT	
Absorptive capability of EEN Partners (average score of the following items):	
% of EEN staff involved in ITT	
% of EEN staff involved in ITT with tertiary education degree	Reddy and Zhao (1990); Cohen and Levinthen (1990) ; Gibson and Smilor (1991); Keller (2001); Gopalakrishnan and Santoro (2004); Santoro and Bierly (2006); Arvanitis and Woerter (2009) Kneller et al. (2010)
% EEN budget invested in training activities (average over the last three years)	Cohen and Levinthal (1990)
Absorptive capability of EEN Clients: (average score of the following items):	
% of employees involved in ITT with tertiary education degree	Reddy and Zhao (1990); Cohen and Levinthen (1990) ; Gibson and Smilor (1991); Keller (2001); Gopalakrishnan and Santoro (2004); Santoro and Bierly (2006); Arvanitis and Woerter (2009); Kneller et al. (2010)
% of the turnover invested in R&D activities (average over the last three years)	Cohen and Levinthal (1990)
% of the turnover invested in training activities (average over the last three years)	
Level of absorptive capability: (average score of the following items):	
Absorptive capability of EEN Partners	
Absorptive capability of EEN Clients	

2.3.5. Network connectedness

As the unit of analysis of this dissertation is the international technology transfer involving a trilateral network, we want to understand whether the connectedness between those organizations and their clients is determinant to the successfulness of the transference. Hence, we follow the work of Santoro and Bierly (2006) to measure the interactions at the individual level of the partnership and to measure the networking dynamics between the EEN and its clients we follow the Triple Helix metrics proposed by Gkikas (2011).

We asked to EEN partners, by reference to the last three years, the (1) number of technological offers (TO) and requests (TR) submitted; (2) number of expression of interest (EOI) and (3) the number of technological partnerships obtain. We also asked to the EEN partner their opinion regarding their role within the client's strategy in the access new ideas, development and transference of new technologies (Table 7). On the other hand, EEN clients where asked how important is the EEN to access, building and transfer technology. Except the overall number of TO/TR, EOI and technological PA, connectedness and networking dynamics indicators were measured using a seven-point Likert-type scale (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree).

Table 7: Measure to estimate the network connectedness between EEN partners and clients

Proxies:	**Source**
Connectedeness between EEN partner and client (average score of the following items):	
Overall number of TO/ TR submitted by the client	Santoro and Bierly (2006)
Overall number of EOI's received/made by the client	
Overall number of Technological PA signed with the client	
Level of networking dynamics (average score of the following items):	
EEN partner networking dynamics (average score of the following items):	
The EEN is an important source of ideas and information for this client's TT process.	Gkikas (2011)
The EEN had helped to develop new technologies that result in new or improved products and services for this client.	
The EEN had played a major role in helping this client transfer and/or acquire new technologies.	
EEN Client networking dynamics (average score of the following items):	
EEN is an important source of ideas and information in my TT process.	Gkikas (2011)
EEN had helped to develop new technologies that result in new or improved products and services.	
EEN had played a major role in helping transfer and/or acquire new technologies.	
Network connectedness (average score of the following items):	
Connectedeness between EEN partner and client	
Level of networking dynamics	

2.3.3. Trust

As referred earlier, EEN foster a proximity relationship between its consultants and its clients. For this reason, in this context, trust was measured blending the interorganizational and interpersonal trust. To measure the client's trust in the EEN partner we blend the work of Mayer et al. (1995), about factors of trustworthiness, with the work of Zaheer et al. (1998) regarding interorganization trust on performance. These blended measures require that the EEN clients assess their trust in the EEN partner in terms of ability, goodwill and integrity of the partner.

Table 8: Measure to estimate the trust relation between EEN partners and clients

Proxies:	**Source**
Trust of EEN Partners (average score of the following items): *Interorganizational trust:*	
Based on past experience, she/he can with complete confidence rely on EEN.	Zaheer (1998)
My client considered me trustworthy.	
Interpersonal trust:	
She/he knows that I to look out for her/his interests.	Zaheer (1998)
My performance was above my client's expectations.	
I was committed in the search of a technological partner.	
She/he was committed in the search of a technological partner.	
Trust:	
My client is perfectly aware and has confidence in my competences and abilities as well as my motives and fairness in sharing these abilities.	Santoro and Bierly (2006)
This client is confident in freely share ideas, feelings, and goals with EEN.	
We share a set of principles that we both find acceptable.	
Trust of EEN Clients (average score of the following items): *Interorganizational trust*	
Based on past experience, I can rely on my EEN with complete confidence.	Zaheer (1998)
Interpersonal trust (average score of the following items):	
She/he is trustworthy.	Zaheer (1998)
I have faith in her/him to look out for my interests.	
Her/his performance was not below my expectations.	
She/he has been committed in the search of a technological partner.	
Trust (average score of the following items):	
I can freely share ideas, feelings, and goals with my EEN.	Santoro and Bierly (2006)
We share a set of principles that I find acceptable.	
I have confidence in her/him competence and abilities as well as its motives and fairness in sharing these abilities.	
Level of trust between EEN partner and its client (average score of the following items):	
Trust of EEN Partner	
Trust of EEN Clients	

However not all of the Zaheer et al.'s (1998) items are applicable to our research. As in these latter authors' work, the items measuring the interorganizational trust were deeply related with a supply-costumes relation. Thus, we had had to adapted and completed it with the measures propose by Mayer (1995).

To access the level of trust between the EEN partners and its clients we asked to EEN partners and clients using a seven-point Likert-type scale (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree) the extent to which they agree with the statements presented in Table 8.

2.3.6. Prior experience with partnerships and international experience

It would be expected that companies or other entities that request EEN services, would have more probability of successfully transfer technology at an international level if they have been already involved in other partnerships or if they have already contact with foreign entities both at commercial or technological level.

Concerning the EEN partners, it is assumed that the entities have prior experience in partnerships as the EEN project is by itself an international partnership. Nonetheless, EEN partners were asked to provide an approximate number of international projects related with technology or technology transfer, in which the host organization was involved in the last three years of activity (Table 9).

With the aim of simultaneously measure the entity experience in national and international partnerships, it was asked to EEN clients to estimate the number of alliances and the number of technological agreements, in which they were involved during the last three years, at both national and international level (Table 10).

Table 9: Measures for prior experience in technological and international partnership

Proxies:
Prior experience of EEN Partners in international or technological projects:
Approximate number of international projects related with technology or technology transfer, in which the host organization was involved, during the last three years of activity.
Prior experience of EEN Partners in international or technological projects:
Approximate number of partnerships established, during the last three years of activity, and relatively to international organizations (e.g., firms, universities, business associations, government organizations).
Approximate number of agreements for technology transfer, during the last three years of activity, and relatively to international organizations (e.g., firms, universities, business associations, government organizations).

2.3.7. Control variables: size and sector

Size and sector were employed as control variables in both questionnaires.

Based on the studies presented in Table 2, size was measured as the number of employees of the entity.

The industrial sector is also referred as having influence in the technology transfer success. For this reason, we classified the EEN members and its clients in accordance with its industrial sector. We use the classification scheme of sector groups. As explain earlier, the EEN members organize themselves into 17[6] different sector groups. We also measured the sector differentiation by the number of sectors where EEN partners and clients are present in terms of activity.

2.4. The process of data gathering

After setting the empirical basis of the research framework and operationalise the relevant variables of the model, the next step was to collect information from the target population.

Due the nature of the agreements, four parts are involved: two EEN partners and two EEN clients.[7] Therefore, to explain the international transference of technology among the Triple Helix, our target population is both the EEN clients and the partners who facilitated that transfer. From the information provided by EEN,[8] 2139 technological partnership agreements were signed from 2008 till 2011.

As referred, our target population includes the EENs and their clients that signed technological PAs. Given that, the link that exists between EEN partners and clients are the PAs, this constitutes our unit of analysis. In this vein, the starting point of the study was to build, in cooperation with the EEN officers, a database with all the technological PAs associated to the EEN partners and their clients.

We started the process of data gathering (c.f. Figure 5) by meeting with the Oporto EEN partner who indicated Mr. Erwan Le Guen, project officer responsible for the project

[6] Sector groups describe in Appendix 1.
[7] In fact, a PA can involve from one till three EEN partners and a similar number of clients. Nevertheless, the vast majority of the PA's are reached involving two EEN partners. For this reason we consider that a PA involves four parties: two EEN partners and two clients. Other occurrences are treated as exceptions.
[8] Information provided by email by Mr. Gunnar Matthiesen (Project Officer - Business Services) on 21st of May 2012.

management evaluation and monitoring in EACI,[9] as the network contact point for issues related with PA. The contacts with Mr. Erwan started on 24th April 2012, with an email presenting our research project and requesting the collaboration of the EEN.

Mr. Erwan answered in the same day, requesting for more details about the project and highlighted that the information about the technological partnership agreements is confidential. Although it is also true that the details from some PA were publicly available as success stories in the EEN website. Additional details were sent on the following day. Given the downtime between contacts and the conversation course, we listed the EEN contact points[10] from 25th till 28th April 2012.

In face of Mr. Erwan's answer, we decided to contact the EACI director, Mr. Patrick Lambert. The first contact was done by email on 2nd May 2012. Phone calls to its office and other email to the secretary was sent during the following days. On 7th May, Mrs. Frieda Desert, Mr. Lambert assistant, indicated that to simplify the process a presentation of the research project should sent to Mr. José Puigpelat, the head of unit from CIP Network Project. This presentation was sent on 8th May 2012. After three days and various attempts to speak with Mr. Puigpelat, his secretary told us that our research project was being discussed internally.

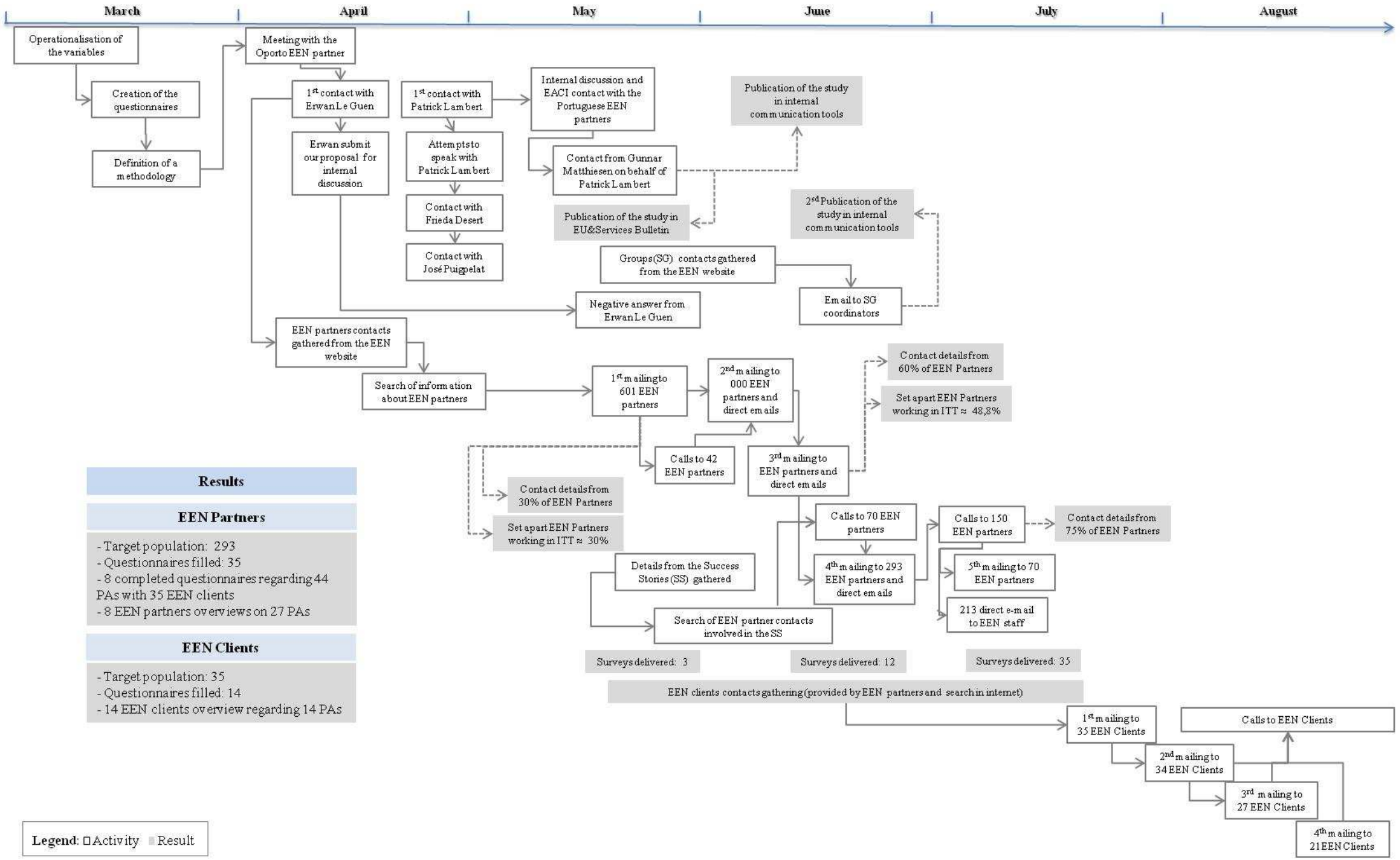
During the next week, we were informed that EACI had contact the leader of the Portuguese consortium and the Oporto network partner. At this time, we were aware that the probability of EEN officers disclose the information we need was low, so we redesign our approach. Renouncing the PA names and the contact details of the EEN clients involved in it, we were then requesting the contact details of EEN partners working in technology transfer topics. The plan was to contact them directly asking about their interest in our research project as well as the openness of their clients to speak about the partnership agreements they signed under the EEN project.

Aware that, in the worst-case scenario, we would get in touch with individual EEN partners, we access the EEN website and create a database with the information available (organization, address, telephone and email).

[9] The Executive Agency for Competitiveness and Innovation (EACI) is the responsible entity for the EEN implementation. The EACI was created by the Commission Decision of 31 May 2007 with the objective of manage the Community actions in energy, entrepreneurship and innovation and sustainable fright transport.

[10] Data collected from the Contact Points at Enterprise Europe Network website (http://portal.enterprise-europe-network.ec.europa.eu/about/branches accessed from 25th till 28th of April 2012).

Figure 5: Schematic overview of data gathering process



On 21st May we were contacted by Mr. Gunnar Matthiesen, an EACI project officer responsible for the Business Services, on behalf of Mr. Lambert. In his email, he provided aggregate statistics about the activities of the Network and informed us that he was not able to provide the information about the PAs neither a list of EEN partners involved in technology transfer agreements because the EEN operates through regional or national consortia which hampers the existence of a consolidated list of partners reporting technological PAs. He refered that the Sector Groups could help us identifying the EEN partners involved in technology transfer.

Mr Gunnar offered to promote our project in the internal communication tools and also suggest its promotion in the LinkedIn discuss group EEN – Technology Transfer. We replied on 22nd May 2012 and in the following day he suggested the publication of the study in the weekly newsletter which we accepted.

Meanwhile, we started the promotion of our study. On 24th May 2012, based on the data collected in April, the survey was sent to 601 EEN partners. Simultaneously, the weekly newsletter was published on 25th May 2012 with a reference to our study. As an incentive a summary of the conclusion were offered to participants.

The EEN partners of our data base included partners working in business, technology transfer topics or both. In an effort to set apart the partners that potentially worked in technology transfer, we started a web search on the host organization. At this stage, we estimated that 30%[11] of the EEN partners worked with technology transfer. The first mailing allowed us to collect a contact person from 30% of the EEN partners, as the contacts points on the EEN website did not included this information.

During this process, on 31st May 2012, we received an e-mail from Mr. Gunnar informing us that the EACI could not give us the information we required.

Given the reduced level of answers and the specificity of the questionnaire, phone calls were made during the days 7 and 8 of June 2012. A second mailing was sent on 11th June 2012 and a third was sent on 19th June 2012. On 25th and 26th June, we reinforce the phone calls.

[11] Estimation based on the core business and website information of the host organizations.

At this stage, and after mailings and phone calls, the partner's feedback allows us to enlarge the estimation of EEN partners working in technology transfer topics to 48% of the total sample (that is, about 293 EEN partners).

On 28th June, the fourth mailing was sent to 281[12] partners and from 4th till 6th and from 9th till 10th July direct phone calls were made. Apart the days dedicated to it, phone calls were done in a smaller scale during the other days. At this stage, as a result of emails, indications and web search, we had a contact person for approximately 73% of EEN partners. During the second week of July, approximately 213 direct emails were sent to the person contacted during the phone calls. An email was also sent to the EEN partner with whom was not possible to speak with and a general email was also sent to the rest of EEN partner in our database.

These efforts resulted in 8 completed questionnaires[13] with information about 44 PAs signed by 35 EEN clients and 9 questionnaires with information regarding 27 PA's but without the contact details. 6 EEN partners provided overall information regarding the PAs they signed. 12 EEN partners, for confidentiality issues or for not having technological PA although working on it, filled the parts regarding the general information and EEN activities. In total 35 EEN partners collaborate in our study providing their feedback on 71 PAs, 46 declined the invitation and the rest didn't give feedback.

With the contact details provided by the EEN partner, the survey to EEN clients had a target population of 35 respondents which corresponds to 44 PAs[14]. This second part of your data gathering started on 30 July 2012 with an email to 35 EEN clients. We reinforce the collaboration request with phone calls and other three emails (on 6th and 21st August and 3rd September). The response rate was 40%,[15] which equals to 14 surveys regarding 14 partnership agreements.

[12] Estimated number of EEN partners working in ITT that did not response the survey or decline the collaboration.
[13] Questionnaire filled with information regarding: the host organization; EEN activities and technological partnerships agreements including title of the agreement, contact details from the client involved and the name of the other EEN partner involved.
[14] Each EEN client can be involved in more than one PA.
[15] Percentage of EEN clients who answer the survey.

Chapter 3. Determinants of International Technology Transfer. Empirical Results

3.1. Initial Considerations

The aim of this chapter is to assess, based on the theoretical framework presented in Chapter 1, the determinants of international technology transfer using the (technological) Partnership Agreements (PAs) of Enterprise Europe Network (EEN).

In the next section we put forward some descriptive results both from the surveys targeting EEN partners and EEN clients. Specifically, we jointly analyze the EEN partners and clients by undertaken a non parametric Kruskal-Wallis test aiming at finding (di)similarities between both samples (EEN partner and EEN clients). Then, in Section 3.3., we briefly summarize the main hypothesis that we want to test. Finally, in Section 3.4, given the lack of information on EEN clients, we use EEN partners' responses regarding the PA signed to econometrically estimate the determinants of international technology transfer (through the lens of EEN partners).

3.2. Brief descriptive analyses

35 EEN partners collaborate in our study from which 8 provide the contact information of their clients, 9 respond the survey but did not provide the contact and 12 did not respond the questions related with the PA. Overall, for the descriptive analyses we considered the EEN partners that proved the information regarding their PAs, i.e. 17, and exclude the rest (12). EEN partners provide the contacts from 35 EEN clients; nevertheless the response rate was 40% which equals to 14 responses.

With the information provided by the EEN partners and clients, we managed to obtain the responses from both EEN partners and clients regarding 14 technological PAs. Thus, respecting to these PAs, we have the perception of these entities on international technology transfer.

It is clear that partners and clients have quite distinct perspectives on the issue of international technology transfer (cf. Table 10). When asked, for a given PA, about the degree of agreement (1- totally disagree --- 7: totally agree) with the statements "The EEN had helped to develop new technologies that result in new or improved products and services for this client" and "The EEN had played a major role in helping this client transfer and/or acquire new technologies", the mean for EEN partners (5.821) reveals

that these entities reckon that international technology transfer was quite successful, resulting in new or improved products and services for this client and helping this client transfer and/or acquire new technologies. The view point of the clients is, however, much more disappointing (scoring below 4), revealing that international technology transfer on clients' perspective was not highly successful. Kruskal Wallis test confirms that such differences are indeed statistically significant (for a level of significance below 1%).[16]

Table 10: Results from the Kruskal-Wallis Test

Variable		Mean value of the Variable		Kruskal-Wallis Test
		EENs	Clients	p-value
International Technology Transfer (IIT)		5.821	3.786	0.003***
Absorptive capability (AC)	Human capital (HC)	1.000	0.919	0.007***
	% staff involved in ITT	0.152	0.356	0.569
	% budget invested in training activities	0.094	0.054	0.015**
	Absorptive capacity	*0.416*	*0.485*	*0.134*
Network Connectedness (NC)	Network dynamics	5.571	3.500	0.003***
	Connectedness			
Trust		6.102	5.120	0.017***
Prior experience in international partnerships (PE)		9.643	5.885	0.016***
Size		51.214	69.500	0.190
Sector diversity (SDIV)		14.857	1.429	0.000***

Note: ***,**,* denote statistical significance at the 1%, 5% and 10%, respectively.

Analysing the variables that were thought relevant for international technology transfer (cf. Chapter 1) - absorptive capability, including human capital, network dynamics, trust, and prior experience in international partnerships – the evidence shows that partners and clients significantly differ on certain dimensions.

Specifically, the human capital endowment (i.e., the percentage of personnel with the tertiary education first cycle) is higher in the case of EEN partners (100%) than clients (91.9%). Budget devoted to training (other item of absorptive capacity) also differ

[16] Kruskal-Wallis test, a nonparametric analysis of variance test that compares the median of two independent samples (For p-values not higher than 10%, the null hypothesis is rejected, i.e., differences exist between the population means):

$\begin{cases} H_0: \text{determinants of ITT are consistence between EEN partners and clients} \\ H_1: \text{determinants of ITT are not consistence between EEN partners and clients} \end{cases}$

significantly with EEN partners devoting a larger share of their budget (almost 10%) to these activities as compared to clients (5%, approximately). The entities do not differ, however, in the absorptive capacity as a whole or in the proportion of staff involved in IT.

The perception regarding the importance of EEN partners as a source of ideas and information for clients's TT process (i.e, network dynamics) is much more positive for EEN partners than for its clients (5.571 versus 3.500). The same happens regarding trust – although trust levels are relatively high (over 5 out of 7), EEN partners tend to perceive higher trust levels in TT relations that their clients do (6.102 versus 5.120). These organizations also differ in prior experience, that is, the number of projects they had participated in the past: on average, approximately 10 in the case of EEN and 6 in clients.

As expected, given their nature, EEN partner and clients strongly differ on the number of sectors where they are present in terms of activity, approximately 15 for partner and 2 for clients.

3.3. Key hypothesis of the 'theoretical' model

The key hypothesis of our theoretical model of ITT is that certain factors are determinant to the successfulness of the international technology transference within a Triple Helix collaboration (Table 11).

Following the literature review in Chapter 1, successful international technology transfer is influenced by: human capital (HC), absorptive capability (AC), network connectedness (NC), trust (Trust), prior experience in international or technological partnership (PE). Moreover, size (Size) and sector diversity (SDIV) also matter (control variables). In algebraic terms, we have:

$$\ln ITT_i = \hat{\beta}_1 + \hat{\beta}_2 HC_i + \hat{\beta}_3 AC_i + \hat{\beta}_4 LnNet_i + \hat{\beta}_5 LnNC_i + \hat{\beta}_6 LnTrust_i + \hat{\beta}_7 LnPE_i + \hat{\beta}_8 LnSize_i + \hat{\beta}_9 LnSDIV_i + \hat{e}_i$$

where e_i is the estimate of the error term.

Table 11: Hypotheses proposed

	Hypotheses description	Determinants
H1	International technology transfer depends directly on organizations' human capital endowment.	Human capital (HC)
H2	The success of an international technology transfer involving a technology broker depends directly on the absorptive capability of the stakeholders.	Absorptive capacity (excl. human capital) (AC)
H3	International technology transfer is facilitated if network connectedness is encouraged.	Network connectedness (NC)
H4	International technology transfer success is positively related with the relation of trust between the technology sender/ recipient and the intermediary hybrid network.	Trust
H5	International technology transfer depends on the prior experience in international or technological partnership.	Prior experience (PE)

Consistent with the results of other studies, a positive relationship is expected between international technology transfer and the relevant variables proposed.

3.4. Determinants of ITT through the lens of EEN partner. Estimation results

The technological PA is an internal document that describes the transference of technology between two EEN clients from different countries and assisted by two EEN partners. In line with this, the model proposed in Section 2.3 encompasses the perspectives from two EEN partners and two EEN clients. Nevertheless, the small sample obtained did not allow the operacionalization of the model as initially proposed. Notwithstanding, we were able to use the EEN partners' questionnaires (N=71) because, as a trilateral network, the perceptions of EEN partners can reflect the determinants of ITT in a Triple Helix framework.

With this in mind, we proceed with a correlation analysis to describe the linear relationship between the model variables relatively to the EEN partners' perception of the determinants that boost the ITT. However, as refered in Section 2.3.1, and by the project definition, the existence of a technological PA implies technology transference between international clients. Therefore, the EEN partner's survey did not included the variables related with successful international transfer of technology. This implies that we device an alternative approach for the dependent variable measurement. Consistent with the technology transfer definition, we adapted the proxy "Networking dynamics" proposed by Gkikas (2011) and use it as a proxy for the successful international transfer of technology. Henceforth, the dependent variable is a measure taking into account EEN

partner perception of its role in the clients' process of building and transfer technology.[17] In the same line of reasoning, the proxy "Networking dynamics" is measured by the EEN perception of its role in the client's access to ideas and information.[18]

At a first glance, the correlation matrix shows that human capital, network connectedness, trust and size are positively and significant correlated with international technology transfer as predicted in the theoretically model. Contrary to our expectations, absorptive capability in negative correlated with our dependent variable.

In a bivariate perspective, the majority of the correlations among independent variables are not considered high, nevertheless significant correlations (estimates of the Pearson correlation coefficient>0.70) are found between trust and network dynamics and between prior experience and size which might put potential problems of multicollinearity if we use these variables in simultaneous in the models estimations.

To avoid the multicollinearity problems in the regression analysis, we use eight models alternating between each of the correlated variable. Additionally, the proposed models also capture the effects of the variables that compose the proxies for absorptive capability and network connectedness (Table 12).

Table 13 presents the estimation results for the models. The results show that the explanatory variables included in the model tend to significantly explain (for p-value < 10%) the successfulness of the international technology transfer in a Triple Helix context. Furthermore, the R^2 adjusted of the models varies between 0.544 and 0.687 which means that between 54.4% and 68.7% of the amount of variance in the successfulness of the international technology transfer is explained by the independent variables considered.

Contrary to our expectations, both human capital and absorptive capability are negatively correlated with international technology transfer. Awkwardly, the estimations suggests that EEN partners with less human resources dedicated to ITT achieve higher results in terms of PAs, which contradicts Hypothesis 1.

[17] The variables are "The EEN had helped to develop new technologies that result in new or improved products and services for this client" and "The EEN had played a major role in helping this client transfer and/or acquire new technologies".

[18] "Networking dynamics" will be measure by the variable "The EEN is an important source of ideas and information for this client's TT process".

Table 12: Correlation analysis for international technology transfer measures on EEN partners[1]

		1	2	3	4	5	6	7	8	9	10	11	12
1. International Technology Transfer (IIT) (ln)		1	0,048	-0,240**	-0,149	-0,161	0,803***	0,116	0,733***	0,656***	0,049	-0,290**	-0,101
Absorptive capability (AC)	2. HC		1	0,106	-0,084	0,641***	0,079	0,022	0,040	0,219	-0,314***	-0,617***	-0,124
	3. Proportion of staff involved in ITT with TE			1	0,435***	0,818***	-0,231*	0,348***	-0,003	0,100	0,306***	0,111	0,388***
	4. Proportion of the budget invested in training				1	0,407***	-0,318**	0,095	-0,131	-0,141	0,083	-0,093	-0,264**
	5. Absorptive capability					1	-0,163	0,267	0,001	0,174	0,042	-0,297**	0,154
Network Connectedness (NC)	6. Network Dynamics						1	0,177	0,734***	0,771***	0,019	-0,238**	-0,092
	7. Connectedness							1	0,724***	0,166	0,111	0,062	0,317***
	8. Network Connectedness								1	0,571***	0,072	-0,136	0,124
9. Trust (ln)										1	0,266**	-0,208*	-0,033
10. Prior experience in international partnerships (PE) (ln)											1	0,641***	0,101
11. Size (ln)												1	0,324***
12. Sector diversity (SDIV) (ln)													1

[1]N= 71.

***,**,* denote statistical significance at the 1%, 5% and 10% test level, respectively

Regarding absorptive capability, the regression models where the proxy was scrutinized (Models 2, 4, 5 and 8) suggest surprising patterns. As a whole, absorptive capability is negatively and significantly related with the success of PAs leading us to reject for this sample the Hypothesis 2. Nonetheless, the variables that constitute the proxy for absorptive capability, apart from human resources, reflect different trends. On one hand, the proportion of staff involved in ITT with tertiary education is surprisingly negative and significant. On the other hand, proportion of the budget invested in training is positive and significant. This means that, on average and ceteris paribus, PAs associated to EEN partners with small teams and higher investments in training tend to reflect more successful ITT.

The estimation coefficients of the regression models presented evidence that the impact of network connectedness in the international transference of technology is positive and significant, corroborating the Hypothesis 3. Globally, network connectedness is positively and highly significant (p-value < 0.001 in Models 1 and 5) but we can further add that network dynamics is the variable that most contribute to this result.

In the same way, the variable trust is positively related with international technology transfer success which supports Hypothesis 4. In the models where trust was included, the corresponding estimated coefficient emerged as positive and highly significant (p-value< 0.001).

The results for the variable prior experience in international or technological partnership are not clear cut. In the models where the variable trust is included (model 3 and 4), the prior experience has a negative and significant estimate. In models without the trust variables (Models 1, 2, 5 and 6), prior experience evidences a positive and significant estimate coefficient in the two most robust models (Models 5 and 6). Hence, given these latter remarks, we might consider that the results supports the Hypothesis 5, being more successful ITT associated with EEN partners with more experience in international or technology partnerships.

Regarding the control variable size, the models present a negatively and significant estimate coefficient with the dependent variable, which indicates that PAs associated with smaller EEN partners are more successful in terms of ITT. For the sector diversity, the results are ambiguous. Nevertheless, in the more robust model (Model 6) the results point out that the sector specialization is an advantage in terms of ITT.

Table 13: Regression models for international technology transfer on EEN partners

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Absorptive capability (AC)	HC		0,105		-0,088		-0,091		-0,260*
	Proportion of staff involved in ITT with TE	-0,298*	-0,270**	-0,618**	-0,434**	-0,746***	-0,292**	-0,818***	-0,388**
	Proportion of the budget invested in training		1,284**		0,795		0,923*		0,499
Network Connectedness (NC)	Network Dynamics	0,622***	0,744***			0,522***	0,650***		
	Connectedness		-0,015				-0,005		
Trust (ln)				0,757***	0,778***			0,679***	0,717***
Prior experience in international partnerships (PE) (ln)		0,004	0,021	-0,028	-0,016	0,075**	0,061*		
Size (ln)						-0,106***	-0,072*	-0,056**	-0,053**
Sector diversity (SDIV) (ln)		-0,048**	0,043	-0,005	0,035	0,003	0,057*	0,019	0,042
Constant		1,15	0,443	0,698	0,658	1,619	0,857	1,025	0,937
N		71	71	71	71	71	71	71	71
R^2 adjusted		0,569	0,652	0,497	0,509	0,668	0,687	0,544	0,545
F-Test (p-value)		24,09 (0,000)	19,752 (0,000)	18,270 (0,000)	13,098 (0,000)	29,197 (0,000)	20,249 (0,000)	21,896 (0,000)	14,989 (0,000)

***,**,* denote statistical significance at the 1%, 5% and 10% test level, respectively

Conclusions

The fundamental theme of the research model in this dissertation is that there are key-factors that can facilitate the international technology transfer in a Triple Helix framework. With a literature review on technological collaboration as our conceptual grounding, we identify the relevant determinants and put forward our hypothesis in a context of international technology transfer. The empirical results obtained from the analyses of technological partnerships agreements signed with the EEN support, showed that international technology transfer in Triple Helix collaboration is related with human capital, absorptive capability, network connectedness, trust and prior experience.

Our first and second hypothesis postulated that human capital and absorptive capability had a positive impact in the successfulness of ITT under the EEN project. Notwithstanding, the results of our empirical model showed the opposite: both human capital and absorptive capability emerged as negatively associated with the ITT. Thus, apparently, a high proportion of staff with tertiary degrees involved in ITT hampers the successful transference of technology across borders. The negative impact of absorptive capability can be explain by the fact that human capital has also a negative tendency, nevertheless the results for human capital are ambiguous (regression results with positive and negative signs) or without statistical significance. In fact, in a close examination to the absorptive capability variables, we can verify that, apart from the human capital, the other two variables have different tendencies. From one side, on average, every other factors remaining constant, the higher the proportion of staff with tertiary degree working with ITT the lower the success associated to the international technology transference. On the other side, higher levels of investment in training seem to be translated into higher propensity for successfully international transfer of technology. Thus, our results underline that high levels of formal schooling per se is not a key determinant of ITT, the critical factor is to have highly educated human resources who complementary to the formal education receive adequate training in TT related issues.

In line with other studies (Santoro and Bierly, 2006; Arvanitis and Woerter, 2009; Laroche and Amara, 2011) the result of our research shows that ITT can be enhanced by network connectedness. A detailed analysis of the variables that constitute the proxy demonstrate that network dynamics, measure by the perception of EEN partner being a source of ideas and information for its client's TT process, is positively and significant

related with improved ITT. In contrast, the connectedness variable, measured by the number of formal outputs between EEN partner and client[19] reflects a negative impact in ITT, although is not significant. This difference in signs and significance can be justified by the impact of more formal or informal contacts in technology transference. The literature refers that informal contacts are the most frequent form of transference (Arvanitis and Woerter, 2009). Indeed, in terms of formality, the exchange of ideas and information is a less formal and tacit process than the creation of documentation.

We also find that ITT process is strongly influenced by the relation of trust built between the EEN partner and its client. This results are in line with previous studies (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006) that describe trust as the glue that foster university and industry alliances.

It is interesting to note, that in the EEN partners sample, trust and network connectedness are significantly correlated ($p<0.10$), as such trust may be a path to connectedness. This not implies that trust necessarily conduct to a network connectedness, but being the last one measured by the perception of EEN partner as a source of ideas and information for its client's TT process, an enlightenment for the association can be found. A high level of trust between organizations, in our case between EEN partners and clients, can enrich their interaction (Santoro and Bierly, 2006), being the client more willing to share their ideas and requirements (Santoro and Bierly, 2006).

Our results also show that the capability of EEN partner of successfully transfer technology among their clients is influenced by its prior experience in international projects related with technology. This can be justified not only by the accumulation of relevant knowledge regarding the appropriate alliances approaches, but also by the capability of more easily identify the collaborative possibilities (Sherwood and Covin, 2008).

Regarding the control variables, size and sector, our research shows that both are negatively correlated with ITT, this means that EEN partners with reduce teams and working in less sectors of activity presents a higher propensity to successfully transfer technology. Considering the results of the variables organization size and proportion of EEN staff dedicated to technology transfer (human capital), the negative impact of both

[19] Technological profiles, expressions of interest and partnership agreements.

variables in ITT may be interpreted as a hint that the overcrowding in an organization are more likely to hinder the international technology transfer than to boost it.

Our results also shows that EEN partners specialized in specific sectors of activities tend to be associated with more successful technology transfer. Although studying the competence specialization in other context (absorptive capability), our result is corroborated by the Santoro and Bierly's (2006) study. In an attempt to clarify the definition of absorptive capability, they refer that, although the importance of R&D intensity measure proposed by Cohen and Levinthal, other authors (Lane and Lubatkin and Mowery et al. in Santoro and Bierly, 2006) argue that only the technological competence of the firm in the specific area of transfer could affect the absorptive capability. In their research results, Santoro and Bierly (2006) found that not only the technological capability measure by the R&D intensity but also the technological relatedness measure by the competence in the area of transference facilitates the knowledge transfer. This can also explains the positive effect of training in absorptive capability.

Summing up, most of the results of the present research met our (and the existing literature) expectations regarding the determinants of international technology transfer within a Triple Helix context. Network connectedness, trust and prior experience are critical for boost the international transfer of technology. Overall, we conclude that training, international experience and network are the basis for a trilateral network broker of international technology transfer in a Triple Helix environment.

While our empirical operationalisation of the Triple Helix framework provides strong support for some ITT determinants that are backed by a solid theoretical background, it nevertheless suffers from methodological limitations. Since the PA involve two EEN partners and their respective clients, our focus in just one side of the PA limits the scope of our model. Collecting data from different intervenients in the PA could have enhanced the data's and results' richness. Also the focus on determinants which props the technological partnership agreements in a Triple Helix scheme barred the study of possible outcomes of the transference. Future studies should attempt to measures the outcomes of technology transfer. Finally we must emphasize that this study has merely provided a description of a very complex dynamics. Therefore, further qualitative and quantitative research capturing the determinants of international technology transfer within the Triple Helix is on demand.

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Appendixes

Appendix 1 - Enterprise Europe Network's Sector groups

(in www.enterprise-europe-network.ec.europa.eu.)

- Agrofood
- Automotive, Transport and Logistics
- Biotech, Pharma and Cosmetics
- Chemicals
- Creative industries
- Environment
- Healthcare
- ICT Industry and Services
- Intelligent Energy
- Maritime Industry and Services
- Materials
- Nano- and Microtechnologies
- Services and Retail
- Space and Aerospace
- Sustainable Construction
- Textile & Fashion
- Tourism and Cultural Heritage

Appendix 2 – Questionnaire implemented to EEN partners

1. GENERAL INFORMATION

Regarding your host organization, please provide the following information:

Type of organization: Private Company, Public company, University, Business/industry Association, Governmental organization

Sector of activity:

- Agrofood
- Automotive, Transport and Logistics
- Biotech, Pharma and Cosmetics
- Chemicals
- Creative industries
- Environment
- Healthcare
- ICT Industry and Services
- Intelligent Energy
- Maritime Industry and Services
- Materials
- Nano and Microtechnologies
- Services and Retail
- Space and Aerospace
- Sustainable Construction
- Textile & Fashion
- Tourism and Cultural Heritage
- All

Number of employees (total):

Number of employees involved in ITT:

Distribution (%) by education level of employees involved in ITT:

- Basic (< 6 years of schooling)
- Secondary (7-12 years of schooling)
- University (> 12 years of schooling)

Considering the last three years of activity, please provide an approximate number of international projects related with technology or technology tranfer, in which your host organization was involved:

2. ENTERPRISE EUROPE NETWORK ACTIVITIES

Considering the last three years of activity, please indicate the % average of the EEN budget:

- Invested in training activities
- Invested in network promotion

Regarding the network promotion and dissemination of technological profiles, please provide:

- Human resources allocated
- Hours by week allocated

Please estimate the overall number of: TO/ TR (Technological offers and technological requests) submitted, EOI's (Expression of Interest), Technological PA (Partnership agreements):

Please provide the importance of the services provided by EEN for fostering international technology partnerships among your clients (1= unimportant; 7 = very important) **and order them** (writing 1 for the most important, 2 for the following and so on)

- Direct contacts
- Brokerage events
- Company Missions
- Fair
- First Class
- BBS Profiles
- Other:

Please provide the importance of the following organizations for your activities in international technology transfer support? Evaluate (1= unimportant; 7 = very important) **and order them** (writing 1 for the most important, 2 for the following and so on)

Frequency of the contacts between you and …(weekly, monthly, yearly, other)

- Other companies (clients, suppliers, …)
- Government (government departments, agencies, …)
- Universities and research centers
- Business and industry associations
- Technology brokers*
- Other:

* Technology brokers: intermediaries between technology suppliers and offers that support companies and other organizations to transfer technology. They act as a network coordinator between industry, university and government.

Which sectors of activity are you and your EEN team dedicated? (you can choose more than one option)

- Agrofood
- Automotive, Transport and
- Biotech, Pharma and Cosmetics
- Chemicals
- Creative industries
- Environment
- Healthcare
- ICT Industry and Services
- Intelligent Energy
- Maritime Industry and
- Materials
- Nano and Microtechnologies
- Services and Retail
- Space and Aerospace
- Sustainable Construction
- Textile & Fashion
- Tourism and Cultural
- All

3. TECHNOLOGICAL PARTNERSHIP AGREEMENTS

Concerning <u>each</u> technological partnership agreement brokered by you as Enterprise Europe Network, please indicate your degree of agreement with the following sentences (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree)

Title of the Partnership agreement:
Client involved in the PA: Contact Person, Email
Other EEN partner involved

- My client considered me trustworthy.
- My client is perfectly aware and has confidence in my competences and abilities as well as my motives and fairness in sharing these abilities.
- She/he knows that I to look out for her/his interests.
- My performance was above my client's expectations.
- I was committed in the search of a technological partner.
- She/he was committed in the search of a technological partner.
- This client is confident in freely share ideas, feelings, and goals with EEN.
- Based on past experience, she/he can with complete confidence rely on EEN.
- We share a set of principles that we both find acceptable.
- The EEN is an important source of ideas and information for this client's TT process.
- The EEN had helped to develop new technologies that result in new or improved products and services for this client.
- The EEN had played a major role in helping this client transfer and/or acquire new technologies.
- Access to the expertise of the EEN has strengthened the client's core area of business.
- Access to the EEN network contacts has strengthened the client's core area of business.

Regarding this specific client, please provide the number of: TO/ TR published, EOIs generated, Other PA (commercial or research)

Appendix 3 – Questionnaire implemented to EEN clients

1. GENERAL INFORMATION

Regarding your organization, please provide the following information:

Type of organization: Private Company, Public company, University, Business/industry Association, Governmental organization

Sector of activity:

Agrofood	Maritime Industry and Services
Automotive, Transport and Logistics	Materials
Biotech, Pharma and Cosmetics	Nano and Microtechnologies
Chemicals	Services and Retail
Creative industries	Space and Aerospace
Environment	Sustainable Construction
Healthcare	Textile & Fashion
ICT Industry and Services	Tourism and Cultural Heritage
Intelligent Energy	All

Number of employees (total):

Number of employees involved in ITT:

Distribution (%) by education level of employees involved in ITT:

- Basic (< 6 years of schooling)
- Secondary (7-12 years of schooling)
- University (> 12 years of schooling)

Considering the last three years of activity, please indicate the average % of the turnover:

- Invested in R&D activities
- Invested in training activities

Considering the last three years of activity, and relatively to international organizations (e.g., firms, universities, business associations, government organizations), please provide an approximate number of:

- Partnerships established
- Agreements for technology transfer

2. RELATIONSHIP WITH ENTERPRISE EUROPE NETWORK (EEN)

Please evaluate the following sentences according with your experience during the last three years with the EEN organization that provides technological and innovation support to your company: (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree)

- I can freely share ideas, feelings, and goals with my EEN.
- We share a set of principles that I find acceptable.
- Based on past experience, I cannot rely on my EEN with complete confidence.
- EEN is an important source of ideas and information in my TT process.
- EEN had helped to develop new technologies that result in new or improved products and services.
- EEN had played a major role in helping transfer and/or acquire new technologies.
- Access to the expertise from the EEN has strengthened my organization's core area of business.
- Access to the EEN network contacts has strengthened my organization's core area of business

3. RELATIONSHIP WITH INDUSTRY, UNIVERSITY AND GOVERMENT

Please evaluate and rate the importance level of the contacts with the following organizations for your technology transfer activities (1= unimportant; 7 = very important) **and rate** (1= less important; 5= more important)**. Considering issues related with technology transfer, how frequent are the contacts between your organization and the following organizations?** (Weekly, monthly, yearly, other)

- Other companies (clients, suppliers, …)
- Government (government departments, agencies, …)
- Universities and research centers
- Business and industry associations
- Technology brokers*
- Other:

* Technology brokers: intermediaries between technology suppliers and offers that support companies and other organizations to transfer technology. They act as a network coordinator between industry, university and government.

4. TECNOLOGICAL PARTNERSHIP AGREEMENTS

Concerning <u>each</u> technological partnership agreement brokered by Enterprise Europe Network and signed by you, please answer the following questions.

PARTNERSHIP AGREEMENT "*Title of the partnership agreement***"**

Evaluate the following statements regarding the EEN consultant involved in the partnership agreement (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree)

- She/he is trustworthy.
- I have faith in her/him to look out for my interests.
- Her/his performance was below my expectations.
- She/he has been committed in the search of a technological partner.
- I have confidence in her/him competence and abilities as well as its motives and fairness in sharing these abilities

According with your role in the partnership, evaluate the following statements (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree)

Sending organization:

- We learn a great deal from the company involved.
- The technology held by my organization was assimilated by the other partner and contributed to development of products/services.
- The technology held by my organization directly resulted in new products and services offered to the other partner customers.

Recipient organization:

- We learn a great deal from the company involved.
- The technology held by the other partner was assimilated by us and contributed to development of products/services.
- The technology held by the other partner directly resulted in new products and services offered to our customers.

Please indicate the frequency of contacts with the EEN consultant involved in these partnership agreements: (Weekly, monthly, yearly, other)