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Determinants of International Technology Transfer: an Empirical Analysis of the Enterprise Europe Network

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Abstract

Given that science and technology are inductors of economic development, the emergence of a knowledge-based economy creates an overlay of communications and expectations that have led to institutional restructuring based on innovative capacities. While the literature tends to concentrate on university-industry relations, this paper intends go a step further, by exploring the university-industry-government relations established in a technology transfer context. Particular attention is paid to the key factors that foster technology transfer within the triad university-industry-government in an international context, i.e., the Enterprise Europe Network (EEN). Based on 71 technological Partnership Agreements (PAs), estimation results indicate that PAs associated to partners that provide their collaborators with the appropriate training in technology transfer-related issues, present substantial past experience in international or technological projects, and participate in extensive networks, are those that achieve better performances in terms of international technology transfer. In contrast, and quite surprisingly, the EEN's human capital endowments and absorptive capacity act as barriers to international technology transfer. A deeper analysis into this latter finding shows that high levels of formal schooling per se are not a key determinant of international technology transfer; indeed, the critical factor is instead highly educated human resources who receive complementary training in technology transfer issues.

Keywords: International technology transfer; Triple Helix; Enterprise Europe Network

JEL-codes:O32;O33;O38

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1. Introduction

Over the last few years, there has been a global move towards a knowledge-based economy (Arvanitis and Woerter, 2009; Lai, 2011), in which knowledge and technology have become the most important resources (Lee et al., 2007) for the endowment of companies and the growth of industries (Laroche and Amara, 2011).

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

Intensive global competition and fast technological development (Santoro and Gopalakrishnan, 2000) have created new challenges for organizations and they are often faced with a lack of resources and time to keep a leading edge (Sherwood and Covin, 2008). This impels them to go beyond their boundaries and look for external sources of knowledge (Sherwood and Covin, 2008; Arvanitis and Woerter, 2009).

This new technological setting has given rise to new linkages between industry (suppliers, customers, competitors) and public organizations, such as research institutions (Arvanitis and Woerter, 2009) and universities (Sherwood and Covin, 2008; Lai, 2011). Universities have become aware of the commercial value of their research and they are now focused on the 'capitalization of knowledge' (Etzkowitz, 1998). Likewise, industry has recognized the positive impact of knowledge produced in universities (Laroche and Amara, 2011) on their innovation and economic performance (Arvanitis and Woerter, 2009).

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

Several studies (e.g., Reddy and Zhao, 1990; Sung et al., 2003; Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006) analyze the key factors of 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 technology transfer within a sector, region or country, neglecting its international dimension.

Moreover, it has disregarded the key factors that sustain the activity of technology transfer intermediaries at international level.

Thus, the present study analyzes international technology transfer within a Triple Helix collaboration with the objective of understanding the key factors that boost technology transfer in this context, and outlines the main features of the entities involved in cases of successful technology transfer. To achieve this objective, we conceptualize the Triple Helix matrix focusing on the European project, Enterprise Europe Network (EEN). Technology transfer in the EEN is closely followed by the partners and can be traced through the partnership agreements (PAs) which are signed by the EEN partners and the beneficiaries involved in the transfer.

Based on direct questionnaires to EEN partners, we analyse their involvement as well as the key features of the owner/originator, intermediary and receptor of the technology. Additionally, the determinants of such transfers can be identified through the analysis of the impact of the technology transfer on the organization.

This paper is organized as follows. The next section provides a review of the literature regarding technology transfer within a triple helix framework. Next, in Section 3, the methodological approach and data gathering procedures are presented. The results are analyzed and discussed in Section 4. Finally, the Conclusions summarizes the main results and puts forward the main limitations and future paths for research.

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

The increasing importance of technology transfer has raised great interest among researchers and policy-makers (Bozeman, 2000) and, in the last few decades, the literature on the topic has flourished, with several authors proposing taxonomies and definitions. Nevertheless, this is a complex, multidisciplinary concept and its definition is still amorphous (Soete and Weel, 1999).

Notwithstanding the vastness of the existing 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 on individuals, firms or countries.

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. Technology transfer is also multidisciplinary in nature and can occur in every field of knowledge, transcending the boundaries of sectors and disciplines (Reisman, 2005). Economists, sociologists, anthropologists, engineers and management theorists have contributed to the topic's knowledge base but each has established a role, a definition and a taxonomy that reflect their own perspectives. This has led to numerous definitions in keeping 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 dimensions of the transfer. 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 transfer can flow through numerous channels (Glass and Saggi, 1999). Categorizing the literature on technology, its process of transfer 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 organizations acquire technology from an external source (Bessant and Rush, 1993; Cumming and Teng, 2003).

The technology transfer process tends to be stimulated if certain key facilitators – e.g., social connectedness, trust, prior experience - are present (Santoro and Bierly, 2006). These facilitators are closely related with: (1) hybrid organizational characteristics (2) clients' characteristics and (3) relations between the hybrid organizations and their clients within a technology transfer process. Among the many determinants of technology transfer proposed, some stand out (cf. Table 1): absorptive capacity, human capital, trust, social connectedness, prior experience with partnerships, international experience. Within a triple helix framework, technology transfer depends on industry characteristics, EEN characteristics and the industry perception of the EEN.

Human capital and absorptive capacity

The determinants of successful technology transfer are closely related with the actors involved. In a transfer process the capacity to absorb and re-use that technology can either enhance or undermine the success of the transfer (Duan et al., 2010).

According to 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 technology transfer between and beyond national boundaries (Keller, 2004; Kneller et al., 2010).

Table 1: Determinants of technology transfer within a Triple Helix framework

Key dimension	Main determinants	Author (year)
Human capital	Technical capabilities	Succar (1987)
	Training	Reddy and Zhao (1990)
	Human Capital	Kneller et al.(2010); Keller (2004);
Absorptive capacity	Absorptive capacity	Reddy and Zhao (1990); Cohen and Levinthen (1990) ; Gibson and Smilor (1991); Keller (2004); 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 with foreign universities	Arvanitis and Woerter (2009)
Size	Firm Size	Gopalakrishnan and Santoro(2004); Santoro and Bierly (2006)
Sector	Sector	Santoro and Bierly (2006)

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

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

Human capital is frequently included in the absorptive capacity (Kneller et al., 2010). Although the term absorptive capacity was presented by Cohen and Levinthen (1990), the idea had been mentioned previously by Madeuf (1983). In his work about international technology transfer and international technology payments, the author states that a transfer can only be successful when the recipient is able to use, reproduce and even improve the technology transfer on its own. Cohen and Levinthen (1990) define absorptive capacity 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, 2004) and, in equal circumstances of access, determines the ability of a company or country to benefit from the technology (Kneller et al., 2010). Not surprisingly, absorptive capacity is referred to

by several authors as a key determinant in the transfer of technology (Cohen and Levinthen, 1990; Keller, 2004; Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006; Kneller et al., 2010).

Despite the literature's focus on the relationship between technology transfer andcapacities and the actors involved in a bilateral perspective, the same connection between the actors of the Triple Helix is also expectable. In the context of our analysis, absorptive capacity will not only determine 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 a 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.

Connectedness and networking dynamics

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

Environments that foster interpersonal relationships can be conductors in the knowledge flow (Santoro and Bierly, 2006), since acquaintances facilitate the working arrangements between partners (Duan et al., 2010). As noted by Sherwood and Covin (2008), familiarity among partners can foster routines of knowledge-sharing, which leads to the mutual understanding of procedures and practices and, consequently, promotes the acquisition of technology.

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

Similarly, the same connectedness between the actors of the Triple Helix is also expected. Indeed, Gkikas (2011) refers to the importance of networking to the innovativeness of a firm. Based on his research in other studies, he concludes that the innovativeness of a firm is

positively correlated with collaboration with other entities, more specifically, among Triple Helix actors.

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

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 described as a mutual belief that the other part will act in view of 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 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's history and culture, Gopalakrishnan and Santoro (2004) also related the likelihood of establishing trust relationships between a company and a university partner with their shared values. According to the authors, companies will tend to trust a university partner if they believe that their strategic objectives will be better achieved by integrating the expertise of the university partner. In fact, the company's willingness to trust relies on its belief in the university partner's expertise and in its availability to share it and to jointly accomplish the company's objectives (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006).

Furthermore, when trust is built between a company and a university partner, confidence regarding abilities and behaviour also increases, as well as the willingness to share ideas and goals (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006).

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

H4: The success of international technology transfer is positively related with the trust relationship between the technology sender/ recipient and the trilateral network.

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 are more prone to 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 more rapidly understand collaboration opportunities, to appropriately manage the alliance and to benefit from it (Santoro and Bierly, 2006; Sherwood and Covin, 2008; Arvanitis and Woerter, 2009). Thus, prior experience can suggest a propensity to establish successful alliances, including partnerships for the transfer of technology (Santoro and Bierly, 2006).

From the perspective of the university-industry collaboration, the company's prior experience in working with a university can be decisive 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.

Control Variables: size and sector

There are different conclusions regarding the influence of an organization's 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), since it defines the partners' interface mechanisms (Sherwood and Covin, 2008). The inclusion of this variable can help us to understand if the success of technology transfer is related with the size of hybrid organizations or/and with the size of the companies that draw on its services.

Previous works conclude that university-industry relationships are highly sector specific (Santoro and Bierly, 2006). Thus, we would also like to determine if technology transfer in the triad is more common in one sector than in another.

3. Methodological underpinnings

The *Enterprise Europe Network* (EEN) is part of the Competitiveness and Innovation Framework Programme (CIP), which is a European Commission programme aimed at fostering the competitiveness of European companies through innovation and eco-innovation activities (EC-CIP, 2008). Building on the Euro Info Centres and Innovation Relay Centres, the EEN was launch on 1st January 2008 with approximately 567 partner organizations located in 44 countries, including EU 17 and neighbouring countries (EC- CIP, 2008). The mission of the EEN 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).

The EEN project was selected as the empirical basis for our research framework because: (1) cross-border cooperation is at the root of the network; (2) as a whole, partners cover the three spheres of the helix, i.e., universities, the private sector and public/governmental entities; (3) to achieve their goals partners have to establish connections amongst themselves, which means the creation of links between entities located in different countries and with different key roles.

According to the operational objectives presented by the Entrepreneurship and Innovation Programme (EC-EIP, 2007), the EEN is built on an integrated service range that combines support to enterprises to bolster their business development in foreign countries with technology and knowledge transfer services (cf. Figure 1).

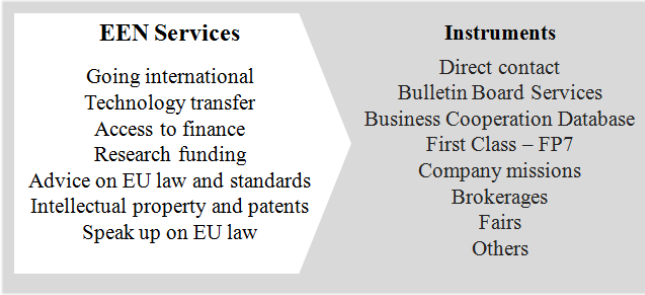

Figure 1: Main services and instruments of the Enterprise Europe Network
Source: Authors' compilation

Synergies among network partners are encouraged in order to guide the client to the most appropriate service provider, in a "no wrong door" philosophy. In the same line, synergies with other local service providers are also promoted to offer complementary services (EC-EIP, 2010). The EEN partners are also responsible for providing information on EU programmes and policies as well as encourage SME participation in the Community Framework Programme for research and technological development (EC-EIP, 2010). Inside the network, partners are committed to the continuous improvement of the services provided,

and to the local diffusion of the network, ensuring the recognition and awareness of its services in the geographical areas covered (EC-EIP, 2010).

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

With regard to technology transfer, it should be mentioned that the EEN services are extending to universities and other research centres interested in establishing a technological partnership whether for development or commercialization. The support typically provided to technology transfer in the EEN is similar to the process exemplified in Figure 2. The client (as mentioned, a company, university and other research centre) with a technological offer or request contacts the local EEN partner, and a meeting is set up. According to the strategy outlined by the organization and the objectives established during the meeting, the best set of instruments will be used to find the right partner. Once found, a Partnership Agreement (PA) is signed by the organizations involved and the EEN partners.

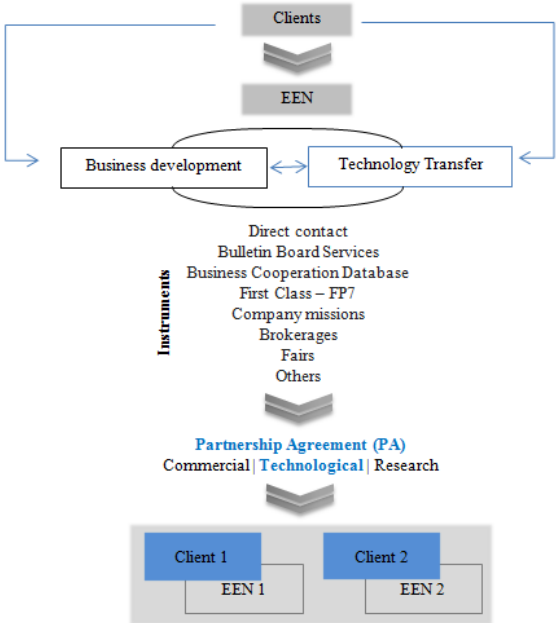

Figure 2: A typical support process in the Enterprise Europe Network

Source: Authors' compilation

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 EENs clients): transfer between two companies; transfer between a company and a university/research centre; transfer between two universities/research centres.

The selection of the relevant variables was guided by the literature review on university-industry partnerships and technology transfer activities. The summary of the determinants of technology transfer proposed indifferent studies are described in Table 2, as well as the proxies used.

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

Transfer technology between international partners is the dependant variable of this study. The transfer 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 have been used (Cumming and Teng, 2003) in the attempt to define successful transfer as a variable, we have followed Madeuf's (1983) approach and assume that the impact on the recipient organization determines the success of the technology transfer.

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

Depending on the function in the transfer, sender or receiver, the participants were asked to evaluatethe degree of learning, assimilation and results arising from the PA involved (Table 3). As mentioned previously, within the EEN, only technological transfers between international partners can be reported as a partnership agreement. Therefore, the PA in this study is, by definition, international.

Table 2: Determinants of technology transfer and proxies

Determinants	Proxy	Variables	Impact in TT	National/ International TT	Sample	Study
Absorptive capacity	Absorptive capacity	Frequency of R&D activities	-/0	National level	Industry-Public research institutions	Arvanitis and Woerter (2009)
		Share of employees with tertiary education intotal employees (in full-time equivalents)	+			
		Investment in R&D	0	International level	Country and firm access to foreign technology	Kneller et al. (2010)
		Provision of formal training	0			
		Workforce education	0			
		R&D intensity (R&D investment divided by the firm's sales revenues)	+	National level	Industry-URC	Santoro and Bierly (2006)
Network connectedness	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]	+			
		Evaluation of closeness of the interactions at individual level of the partnership	+		Industry-URC	Santoro and Bierly (2006)
	Social relation	Intensity of linkages with managers and/ or professionals from five types of organizations	+		Transfer activities among Canadian researchers in occupational safety and health	Laroche and Amara (2011)
	Technological relatedness	Impact of accessing the URC expertise			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 significance
.

Determinants	Proxy	Variables	Impact in TT	National/ International TT	Sample	Study
Trust	Trust	Willing to share ideas, feelings and goals with the university centre	+	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	+			
		Firm willingness toshare concerns and problems with the URC	+			Santoro and Bierly (2006)
		Firm awareness ofURC capability in understanding their needs	+			
		Firm willingness toshare confidences with the URC	+			
		Sharing of common business values	+			
		Willing to share ideas, feelings and goals with the university centre	+		Institutionalization of knowledge transfer within University-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		Industry-URC	Santoro and Bierly (2006)
		Number of prior technology transfer agreements with the universities	-		University-Industry	Sherwood and Covin (2008)
Size	Size	Number of employees	Control variable		Industry-URC	Santoro and Bierly (2006)
			+			Gopalakrishnan and Santoro (2004)[2]
	Sector	High tech and capital intense[3]	Control variable			Santoro and Bierly (2006)

Notes: [2]The authors use the 7-S Framework as a theoretical basisto 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 moulding, and ceramics).

Legend: + Positively related; (-) negatively related; (0) no significant

Table 3: 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 the development of products/services.	
The technology held by my organization directly resulted in new products and services offered to the other partner's 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 the development of products/services.	
The technology held by the other partner directly resulted in new products and services offered to our customers.	

R&D activities, workforce education and *training* are pointed out by numerous authors as the main indicators of a firm's absorptive capacity (Santoro and Bierly, 2006; Arvanitis and Woerter, 2009; Kneller et al., 2010). Although the authors are consensual about the importance of R&D, workforce and training, there is a lack of agreement regarding the proxies to be used to reflect the absorptive capacity of an organization. The educational achievement of the organizations' 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 the capabilities and skills of the EEN consultants in the network's strategy and activity (EC-EIP, 2010), we compute the proxy for absorptive capacity of the EEN partners based on the education level of the consultancy staff and the average EEN budget invested in training activities in technology-related fields (Table 4- EEN Partners).

In the same way, the absorptive capacity of the EEN clients is measured by the education level of the employees involved in ITT and the average of the turnover invested in training activities in technology-related fields. In addition 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 in the company's sales revenue (Tables 4 -EEN Clients). This measure helps us to understand the client's technological capability and therefore its capacity to transfer technology.

Table 4: Measure to estimate the human capital and the absorptive capacity 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 capacity of EEN Partners (average score of the following items):	
% of EEN staff involved in ITT	
% ofEEN staff involved in ITTwith tertiary education	Reddy and Zhao (1990); Cohen and Levinthen (1990); Gibson and Smilor (1991); Keller (2004); 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 capacity of EEN Clients: (average score of the following items):	
% of employees involved in ITT with tertiary education	Reddy and Zhao (1990); Cohen and Levinthen (1990); Gibson and Smilor (1991); Keller (2004); 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 capacity: (average score of the following items):	
Absorptive capacity of EEN Partners	
Absorptive capacity of EEN Clients	

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

With reference to the last three years (2009-2011), the EEN partners were asked about 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 obtained. They were also queried about their opinion regarding their role within the client's strategy in accessing new ideas, and developing and transferring new technologies (Table 5).

Additionally, EEN clients where asked how important the EEN is in accessing, building and transferring technology. Except for the overall number of TO/TR, EOIs and technological

PAs, 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 5: Measure to estimate thenetwork connectedness between EEN partners and clients

Proxies:	**Source**
Connectedness 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 EOIsreceived/made by the client	
Overall number of Technological PAssigned 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):	
The EEN is an important source of ideas and information in my TT process.	Gkikas (2011)
The EEN had helped to develop new technologies that result in new or improved products and services.	
The EEN had played a major role in helping transfer and/or acquire new technologies.	
Network connectedness (average score of the following items):	
Connectedness between EEN partner and client	
Level of networking dynamics	

As mentioned earlier, the EEN fosters a relationship of proximity between its consultants and its clients. For this reason, trust was measured by blending inter-organizational and interpersonal trust. To measure the client's trust in the EEN partner, we combined the work of Mayer et al. (1995) on factors of trustworthiness, with the work of Zaheer et al. (1998) regarding inter-organizational trust on performance. These combined measures required the EEN clients to assess their trust in the EEN partner in terms of ability, goodwill and integrity. However, not all of the Zaheer et al.'s (1998) items were applicable to our research. As in the aforementioned authors' work, the items measuring inter-organizational trust were closely related with a supply-costumer relation. Thus, we had to adapt and complete it with the measures proposed by Mayer (1995).

To assess the level of trust between the EEN partners and their clients, the EEN partners and clients were questioned about the extent to which they agree with the statements presented in Table 6, on a seven-point Likert-type scale (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree).

Table 6: Measure to estimate the trust relationship between EEN partners and clients

Proxies:	Source
Trust of EEN Partners(average score of the following items):	
Inter-organizational trust:	
Based on past experience, she/he can rely on the EEN with complete confidence.	Zaheer (1998)
My client considered me trustworthy.	
Interpersonal trust:	
She/he knows that I look out for her/his interests.	Zaheer (1998)
My performance was above my client's expectations.	
I was committed tothe search fora technological partner.	
She/he was committed tothe search fora technological partner.	
Trust:	
My client is perfectly aware of 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 tofreely share ideas, feelings, and goals with the EEN.	
We share a set of principles that we both find acceptable.	
Trust of EEN Clients(average score of the following items):	
Inter-organizational 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 tothe search for 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/his competence and abilities as well as her/hismotives 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	

It would be expected that companies or other entities that request EEN services would be more prone to successfully transferring technology at an international level if they had already been involved in other partnerships or if they had already established contacts with foreign entities, whether at commercial or technological level.

Concerning the EEN partners, it was assumed that the entities have prior experience in partnerships as the EEN project is in 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 had been involved in the last three years of activity (Table 7). With the aim of measuring the entity's experience in both

national and international partnerships, EEN clients were asked to estimate the number of alliances and the number of technological agreements in which they had been involved in the last three years, both nationally and internationally.

Table 7: Measures for prior experience in technological and international partnerships

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

Size and sector were employed as control variables in both questionnaires. Based one arlier studies (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006), size was measured as the entity's number of employees.

The industrial sector is also highlighted as influencing the success of technology transfer (Santoro and Bierly, 2006). For this reason, we classified the EEN members and their clients in accordance with their industrial sector, based on the classification scheme of sector groups. The EEN members are organized into 17 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.

Due the nature of the agreements, four parties are usually involved: two EEN partners and two EEN clients.[1] Therefore, to explain the international transfer of technology within the Triple Helix, our target population is both the EEN clients and the partners who facilitated that transfer. From the information provided by the EEN,[2] 2139 technological partnership agreements were signed from 2008 to2011.

Our target population was the EEN partners and their clients that signed technological PAs, which comprised our unit of analysis. The study's starting point was, hence, to build, in cooperation with the EEN officers, a database with all the technological PAs associated to the EEN partners and their clients.

[1] In fact, a PA can involve one to three EEN partners and a similar number of clients. Nevertheless, the vast majority of the PAs involves 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.

[2] Information provided by email by Mr. Gunnar Matthiesen (Project Officer - Business Services) on 21stMay 2012.

The data gathering process was fraught with difficulties and institutional obstacles. It involved several hierarchical layers within the EEN: the Oporto EEN, the officer responsible for the project management evaluation and monitoring in the EACI,[3] as the network contact point for issues related with PAs, the EACI director, and the unit head of the CIP Network Project. The contacts were made from 24th April to mid-May 2012.

Faced with these difficulties in accessing the required information, we redesigned our approach. We had to give up on obtaining the names and contact details of the EEN clients involved in the PA, and decided to request the contact details of the EEN partners working in technology transfer activities. The plan was to contact them directly to determine their interest in our research project, as well as ascertain the openness of their clients to provide information about the partnership agreements they had signed under the EEN project. At this stage, as we were aware that, in the worst-case scenario, it would be necessary to get in touch with individual EEN partners, we accessed the EEN website and created a database with the information available (organization, address, telephone and email).

The survey and information on our study was first sent on 24th May 2012to 601 EEN partners based on the data collected in April. In an effort to encourage the recipients to collaborate, a summary of the expected conclusions was also included. The EEN partners in our database included partners working in business or technology transfer activities, or both. In an effort to identify the partners that potentially worked in technology transfer, we conducted a web search on the host organization. At this stage, we estimated that 30%[4] 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 include this information.

Given the low rate of response and the specificity of the questionnaire, phone calls were made on 7thand 8thJune 2012. A second mailing was sent on 11th June and a third on 19th June. On 25th and 26th June, we again made a number of phone calls. At this stage, after the mailings and phone calls, the partners' feedback broadened the estimation of EEN partners working in technology transfer to 48% of the total sample (that is, about 293EEN partners).

[3]The Executive Agency for Competitiveness and Innovation (EACI) is responsible for the EEN implementation. The EACI was created by the Commission Decision of 31 May 2007 with the objective of managing the Community actions in energy, entrepreneurship and innovation, and sustainable freight transport.
[4]Estimation based on the core business and website information of the host organizations.

On 28th June, a fourth mailing was sent to 281[5] partners and 5 days in July 2012 (4th, 5th, 6th, 9thand10th) were dedicated to making direct phone calls (calls were made less intensively on other days as well). At this stage, as a result of emails, indications and web searches, it had been possible to identify 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 which it had not been possible to speak with a contact person, and a general email was also sent to the rest of EEN partners in our database.

These efforts resulted in 8 complete questionnaires[6] with information on44 PAs signed by 35 EEN clients and 9 questionnaires with information regarding 27PAs but without the contact details. 6 EEN partners provided overall information regarding the PAs they had signed. 12EEN partners, due to confidentiality reasons or because they did not yet have a technological PA (but were working on it), filled the parts regarding the general information and EEN activities. In total, 35 EEN partners collaborated in our study, providing feedback on 71 PAs, 46 declined the invitation and the rest did not respond.

With the contact details provided by the EEN partners, the survey of EEN clients resulted in a population of 35 respondents corresponding to 44 PAs.[7] The second part of our data gathering started on 30thJuly 2012 with an email to 35 EEN clients. We reinforced the request for collaboration with phone calls and three additional emails (on 6th and 21st August and 3rd September). The response rate was 40%,[8] which corresponds to 14 surveys regarding 14 partnership agreements.

4. Determinants of International Technology Transfer (ITT). Empirical Results

4.1. Brief descriptive analyses

It is clear that partners and clients have quite distinct perspectives on the issue of international technology transfer (cf. Table 8). When asked, with regard to 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

[5] Estimated number of EEN partners working in ITT that did not answer the survey or declined the invitation.
[6] The questionnaire asked for information regarding: the host organization; EEN activities and technological partnerships agreements including title of the agreement, contact details of the client involved and the name of the other EEN partner involved.
[7] Each EEN client can be involved in more than one PA.
[8] Percentage of EEN clients that answered the survey.

new technologies", the mean for EEN partners (5.821) reveals that they 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 viewpoint of the clients is, however, much more disappointing (scoring below 4), revealing that international technology transfer from the clients' perspective was not very successful. The Kruskal Wallis test confirms that such differences are indeed statistically significant (for a level of significance below 1%).

Analyzing the variables that were thought relevant for international technology transfer (cf. Section 2) - absorptive capacity, including human capital, network dynamics, trust, and prior experience in international partnerships – the evidence shows that partners and clients differ significantly on certain dimensions.

Specifically, the human capital endowment (i.e., the percentage of personnel with a tertiary first cycle education) is higher in the case of EEN partners (100%) than clients (91.9%). The budget devoted to training (another item of absorptive capacity) also differs significantly, with EEN partners devoting a larger share (almost 10%) to these activities as compared to clients (approximately 5%). The entities do not differ, however, in absorptive capacity as a whole or in the proportion of staff involved in ITT.

Table 8: Results from the Kruskal-Wallis Test

Variable		Mean value of the Variable		Kruskal-Wallis Test
		EENs	Clients	p-value
International Technology Transfer (ITT)		5.821	3.786	0.003***
Absorptive capacity (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. The analysis includes 28 responses associated to 14 PAs (responded simultaneously by EENs and Clients).

The perception regarding the importance of EEN partners as a source of ideas and information for the clients' TT process (i.e., network dynamics) is much more positive for EEN partners than for their clients (5.571 versus 3.500). The same occurs regarding trust – although trust

levels are relatively high (over 5 points in a maximum of 7), EEN partners tend to perceive higher trust levels in TT relations than their clients (6.102 versus 5.120). These organizations also differ in prior experience, that is, the number of projects they have participated in in the past: on average, approximately 10 in the case of EEN and 6 in clients.

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

4.2. Key hypothesis of the 'theoretical' model

The key hypothesis of our theoretical model of ITT is that certain factors are crucial to the success of international technology transfer within a Triple Helix collaboration (Table 9). Following the literature review in Section 2, successful international technology transfer is influenced by: human capital (HC), absorptive capacity (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 9: Hypotheses proposed

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

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

4.3. Determinants of ITT through the lens of EEN partners. Estimation results

The technological PA is an internal document that describes the transfer of technology between two EEN clients from different countries and assisted by two EEN partners. In line with this, the original model proposed encompassed the perspectives of two EEN partners and two EEN clients. The small sample obtained rendered the model as initially proposed unviable. Although perceptions of EEN partners and clients differ (as seen earlier in Section 4.1), as a trilateral network, the perceptions of EEN partners are likely to reflect the determinants of ITT in a Triple Helix framework. Thus, we used the EEN partners' questionnaires, totalling 71 responses, as the basis of analysis for this part.

We proceeded with a correlation analysis to describe the linear relationship between the model variables regarding the EEN partners' perception of the determinants that boost ITT. However, due to the project definition, the existence of a technological PA implies technology transfer between international clients. Therefore, the EEN partners' survey did not include the variables related with successful international technology transfer. This meant that we had to devise an alternative approach to measure the dependent variable. Consistent with the technology transfer definition, we adapted the proxy "Networking dynamics" proposed by Gkikas (2011) and used it as a proxy for the successful international transfer of technology. Henceforth, the dependent variable is a measure taking into account the EEN partners' perception of their role in the clients' process of building and transferring technology.[9] In the same line of reasoning, the proxy "Networking dynamics" is measured by the EEN perception of its role in the clients' access to ideas and information.[10]

At 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 capacity 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 raise potential problems of multicollinearity if we use

[9]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".

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

these variables simultaneously in the models' estimations. To avoid multicollinearity problems in the regression analysis, we use eight models alternating between each of the correlated variables. Additionally, the proposed models also capture the effects of the variables that compose the proxies for absorptive capacity and network connectedness (Table 10).

Table 10: Correlation analysis for international technology transfer measures on EENpartners[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 capacity (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 capacity					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.

Table 11 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 success of international technology transfer in a Triple Helix context.

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

Regarding absorptive capacity, the regression models where the proxy was scrutinized (Models 2, 4, 5 and 8) reveal surprising patterns. As a whole, absorptive capacity is negatively and significantly related with the success of PAs leading us to reject Hypothesis 2 for this sample. Nonetheless, the variables that constitute the proxy for absorptive capacity,

apart from human resources, reflect different trends. On the one hand, the proportion of staff involved in ITT with tertiary education is surprisingly negative and significant. On the other hand, the 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.

Table 11: 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 capacity (AC)	HC	-0,298*	0,105	-0,618**	-0,088	-0,746***	-0,091	-0,818***	-0,260*
	Proportion of staff involved in ITT with TE		-0,270**		-0,434**		-0,292**		-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.

Globally, network connectedness is positively and highly significant (p-value < 0.001 in Models 1 and 5), corroborating Hypothesis 3, but we can further add that network dynamics is the variable that most contributes to this result. In line with other studies (e.g., Santoro and Bierly, 2006; Arvanitis and Woerter, 2009; Laroche and Amara, 2011), we found that ITT can be enhanced by network connectedness. A detailed analysis of the variables that constitute the proxy demonstrate that network dynamics, measured by the perception that the EEN partner is a source of ideas and information for its client's TT process, is positively and significantly related with improved ITT. In contrast, the connectedness variable, measured by the number of formal outputs between EEN partner and client,[11] reflects a negative impact on ITT, although it is not significant. This difference in signs and significance can be justified by the

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

impact of more formal or informal contacts in technology transfer. The literature mentions that informal contacts are the most frequent form of transfer (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.

Similarly, the trust variable is positively related with the success of international technology transfer which supports Hypothesis 4. In the models where trust is included, the corresponding estimated coefficient emerges as positive and highly significant (p-value< 0.001). This result is in line with previous studies (Gopalakrishnan and Santoro, 2004; Santoro and Bierly, 2006) that describe trust as the glue that fosters university and industry alliances.

It is interesting to note that, in the EEN partners sample, trust and network connectedness are significantly correlated ($p<0.10$) and, as such, trust may be a path to connectedness. This does not imply that trust necessarily leads to network connectedness, but since the latter is measured by the perception that the EEN partner is a source of ideas and information for its client's TT process, 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, where the client is more willing to share their ideas and requirements (Santoro and Bierly, 2006).

The results for the variable, prior experience in international or technological partnerships are not clear cut. In the models where the trust variable is included (model 3 and 4), prior experience has a negative and significant estimate. In models without the trust variable (Models 1, 2, 5 and 6), prior experience reveals a positive and significant estimate coefficient in the two most robust models (Models 5 and 6). Hence, given these latter findings, we might consider that the results support Hypothesis 5, where more successful ITT is associated with EEN partners with more experience in international or technology partnerships. This can be justified not only by the accumulation of relevant knowledge regarding the appropriate alliance approaches, but also by the ability to more easily identify collaborative possibilities (Sherwood and Covin, 2008).

Regarding the control variable, size, the models present a negative and significant estimate coefficient with the dependent variable, which indicates that PAs associated with smaller EEN partners are more successful in terms of ITT. This may be interpreted as a hint that

'overcrowding' in an organization is more likely to hinder international technology transfer than to boost it.

For the sector diversity, the results are ambiguous. Nevertheless, in the more robust model (Model 6), the results suggest that sector specialization is an advantage in terms of ITT. Although studying competence specialization in other contexts (absorptive capacity), our result is corroborated by Santoro and Bierly's (2006) study. In an attempt to clarify the definition of absorptive capacity, they mention that, despite the importance of R&D intensity, only the technological competence of the organization in the specific area of transfer could affect the absorptive capacity. In their research results, Santoro and Bierly (2006) found that not only technological capability (measured by the R&D intensity), but also technological relatedness (measured by competence in the area of transfer) facilitate knowledge transfer. This can also explain the positive effect of training on absorptive capacity.

5. Conclusions

The empirical results obtained from the analyses of technological partnership agreements signed with EEN support, showed that international technology transfer in Triple Helix collaboration is related with human capital, absorptive capacity, network connectedness, trust and prior experience.

Our first and second hypotheses postulated that human capital and absorptive capacity had a positive impact on the success of ITT under the EEN project. Notwithstanding, the results of our empirical model showed the opposite: both human capital and absorptive capacity emerged as negatively associated with ITT. Thus, apparently, a high proportion of staff with tertiary degrees involved in ITT hampers the successful transfer of technology across borders. The negative impact of absorptive capacity can be explained by the fact that human capital also has 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 of the absorptive capacity variables, we found that, apart from the human capital, the other two variables have different tendencies. On the one hand, on average, all other factors remaining constant, the higher the proportion of staff with tertiary degrees working with ITT, the lower the success associated to international technology transfer. On the other hand, higher levels of investment in training seem to translate into a higher propensity for successful international technology transfer. Thus, our results underline that high levels of formal schooling per se are not a key determinant of ITT; the critical factor is to

have highly educated human resources who receive complementary training in TT-related areas.

Summing up, we conclude that training, international experience, and networks are, overall, the basis for a trilateral network broker of international technology transfer in a Triple Helix environment.

While our empirical operationalization 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. First, given that the PA involves two EEN partners and their respective clients, our focus onjust one side of the PA limits the scope of our model. Collecting data from different participants in the PA could have enhanced the data's and results' richness. Secondly, the focus on determinants which prop the technological partnership agreements in a Triple Helix scheme barred the study of the possible outcomes of the transfer. Future studies should attempt to measure the outcomes of technology transfer. Finally, we must emphasize that this study has merely provided an outline of very complex dynamics. Therefore, further qualitative and quantitative research capturing the determinants of international technology transfer within the Triple Helix is required.

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