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The Impact of Company Relationship and Institution Technology on R&D Activity and Innovation

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1. Introduction

In today's competitive environment, the activities of a business cannot be imagined in an isolated manner, nor can they be exclusively associated with commercial-type relations (purchasing and sales of goods and services) as they were in the 1980s and 1990s (Buhman, et al., 2005; Más Ruíz, 2000). We are currently living in a networking society where strong interdependencies among actors are created through networks and inter-organizational alliances (Tikkanen & Parvinen, 2006), where today's companies are network-centric enterprises (Buhman et al., 2005), and where the external environment affects company behavior. At the same time, the companies, their culture and their learning processes influence the external stakeholders with whom they have relations (Minguzzi & Passaro, 2000). Therefore, companies must take into account not only their stage of development but also the development of the industry, in order to maximize their learning capability (Benson-Rea & Wilson, 2003) based on their relations with the other stakeholders located in the same region or country, and thus contribute to the development of competitive advantages at both business and regional levels (Bell & Albu, 1999; Carbonara, 2002; Dohse & Soltwedel, 2006; Feldman et al., 2005).

Section 1 presents some common proposals and perspectives based on the study of inter-company relations and of company-institution relations using the following theoretical approaches: agglomeration economics, clusters and industrial districts, and networking. Section 2 addresses theoretical aspects regarding R&D activities and innovation in a business network environment and proposes the hypotheses for this article. Section 3 explains the research methodology; based on the literature on the topic, it indicates the main methodologies employed in this article and defines analysis variables. Section 4 presents the general theoretical and empirical findings. And finally suggests future lines of research.

2. The study of inter-company relations and of company-institution relations

Inter-company relations as well as company-institution relations (public and private institutions) are determining factors for business competitiveness and contribute to the

socioeconomical development of the area where they are located. They especially influence the companies' innovation and R&D capabilities. The study of these relations is based on the concepts of agglomeration economics, clusters and industrial districts, and networking.

These different concepts have theoretical aspects in common, such as:

- The existence of a company cluster in a clearly delimited territory (concentrated in one space) through which the companies take advantage of externalities resulting from their proximity (Alonso-Villar et al., 2004; Bell, 2005; Feser & Bergman, 2000; Mella et al., 2007; Nassimbeni, 2003)
- High levels of specialized goods and services, knowledge flows and innovations, and intense, constant technological change (Antonelli, 2006; Beesley, 2004; Callois, 2008; Carbonara, 2002; Groenewegen & Van Der Steen, 2006; Hagedoorn & Duysters, 2002; Hervás & Dalmau, 2006; OECD, 1999 a, 1999b)
- Building and sustaining vertical and horizontal relations of inter-company trust and of trust between companies and other stakeholders in and outside the territory (Brenner & Greif, 2006; Dohse & Soltwedel, 2006; Eraydin & Armatli-Köroglu, 2005; Hotz-Hart, 2002; McCann, 1995; Tracey & Clark, 2003; Walker et al., 1997)

And from a practical view, the empirical research conducted in the context of the above concepts has the following perspectives well worth mentioning.

- Local business networks and their role in the development of knowledge, of innovation processes, and in innovation results (Baptista, 1996; Baptista & Swam, 1998; Beaudry & Breschi, 2003; Beesley, 2004; Bell, 2005; Brenner & Greif, 2006; Hagedoorn & Duysters, 2002; Hervás & Dalmau, 2006; Muscio, 2006; Wolfe & Gertler, 2002; Yogel et al., 2000; Zhang, 2007)
- The importance of business networks in business strategy, productivity and competitiveness, and business infrastructure (Carbonara, 2002; Carrie, 1999; Feldman et al., 2005; Hervás et al., 2007; Lechner & Dowling, 2003)
- Business networks and their incidence *vis à vis* the job market, human resources and company development (Blasio & Di Addario, 2005; Hervás & Dalmau, 2006; Hu et al., 2005; Power & Lundmark, 2004; Pöyhönen & Smedlund, 2004)
- Business networks and public policies for regional economic development at State, regional, city or location level (Altengurg & Meyer-Stamer, 1999; Dohse & Soltwedel, 2006, Gibb, 2006; Jensen, 1996; Koch et al., 2006; Lai et al., 2005; McDonald et al., 2006; Oyelaran-Oyeyinka & Lal, 2006; Viladecans-Marsal, 2004).

All of the aspects mentioned above prove the importance of inter-company relations as well as of company-institution relations because of their positive influence not only on the economic and social development of specific areas but also on each company's development, especially in the development of technological capabilities for innovation. Likewise, a conclusion to be drawn is that the studies on inter-company relations are based on the idea of networks, which may allow inferring that "the business network" (Becerra, 2008) is the common unit of analysis, independently of the proposals presented in each approach.

3. Innovation as a process: Innovation activities

The idea of innovation stems from Schumpeter's ground-breaking work that proposes that innovation is achieved upon introducing a new product or a modified product, upon

inventing a new method of doing something, upon entering a new market or finding a new source of provisioning, or upon creating a new organization (Schumpeter, 1997), which basically implies understanding innovation as a result. Along the same lines, Damanpour (1987) differentiates technological innovations and administrative innovations, and classifies innovations as radical innovations and as incremental innovations (Gopalakrishnan & Damanpour, 1997), according to the degree of innovation.

The Oslo Manual states that innovation "is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method, in business practices, workplace organization or external relations," (OECD/EUROSTAT, 2005, pg. 46). This definition comprises the different ideas discussed in the literature on the topic and highlights the external relations of a company, meaning that it alludes to the relational capital (Capello, 2002; Capello & Faggian, 2005) that can be found in business networks, which is the object of this study although the above is based on a perspective of innovation as a result.

Innovation as a process, not as a result, implies understanding the activities that take place in order for new ideas, objects and practices to be created, developed or reinvented (Slappendel, 1996). In that sense, the literature on the topic refers to stages that occur from the time when an invention is created to the time when it is commercialized. Such stages include research (basic and applied), R&D, the development of prototypes and models, the acquisition of technology, and some project engineering stages (OECD, 2002, OECD/EUROSTAT, 2005; Rammer & Schmiele, 2009). Nevertheless, the stages are recursive rather than sequential, in which knowledge is developed, communicated and transferred (Robertson et al., 1997 as cited in Edwards, 2003), resulting in an "interactive process" that is common in the field of innovation and that has been used to describe intra-company and inter-company innovation activities (Rothwell et al., 1990 as cited in Edwards, 2003). Innovation activities that use that process are the main input for obtaining innovations (results) and they are also essential in building knowledge and technological capabilities in the company.

4. Innovation activities (R&D and TKT) as determinants of business innovation and R&D activities

According to the Oslo Manual, "innovation activities are all those scientific, technological, organizational, financial and commercial steps, including investment in new knowledge, which actually lead to, or are intended to lead to, the implementation of innovations," (OECD/EUROSTAT, 2005, pg. 91), which implicitly includes R&D. According to the Frascati Manual, R&D includes basic research, applied research, and experimental development[1]. Other activities that are not technically R&D activities but that are carried out in R&D projects are also included in this category[2].

[1] This article focuses on experimental development because the characteristics proper to the Colombian economy and more specifically to the Provincial Department of Caldas, mostly comprising traditional manufacturing industry micro-companies and small and medium-sized companies (SME), do not allow assuming that the companies on their own or in association with other companies or institutions conduct basic or applied research (or if they do, it is solely residual).

[2] (See OECD, 2002, pg. 30-33).

Among the activities related to knowledge flow and technology (Oslo Manual, 2002 and Bogotá Manual, 2001) that are carried out in a business network environment, the activities related to machinery and equipment, specialized software, technical and technological information, and the dissemination of R&D and innovation results (Arvanitis et al., 2007) are included under technology and knowledge transfer (TKT) as determinants of the innovation and R&D proper to a company.

In summary, this article analyses the innovation activities (R&D and TKT) that stem from business network links and that are incentives for company R&D as well as for business innovation (product, process, and administrative innovations).

The influence of business network R&D on company innovation and R&D activities has been proposed in the empirical literature on the topic. By observing the systemic interactions that can favor or hinder innovation activities in the four regional innovation systems in Italy, Evangelista et al. (2002) found that there were differences in the level of importance given to R&D activities and to non-R&D activities at a company level. By studying the impact of relational capital on innovation in urban areas and non-urban areas and in the industrial districts of the Emilia Romagna, Capello (2002) found that relational capital had an impact on company innovation activities, which mostly benefited the large production companies in the district. Capello also found that relational capital had a positive impact on product innovation in small companies that operate in specialized sectors as they achieve synergies and cooperation with one another. The above was later reinforced by Capello & Faggian (2005) who established a positive relation between relational capital and company innovation activity.

Taking the R&D expenses of a company in a network context as a reference, Filatochev et al. (2003) found a positive significant relation between the intensity of R&D activities in firms and the industry concentration. Capello & Faggian (2005) affirm that the "physical proximity" between firms plays a crucial role in the increase of a firm's innovation capability, especially thanks to knowledge spillovers. Cassiman & Veugelers (2006) suggest that internal R&D activities and knowledge acquisition and innovation activities are complementary; regarding basic R&D, they suggest the importance of universities and research centers as sources of information for innovation processes.

Analyzing the determinants of R&D cooperation between innovative firms (foreign and domestic) and universities and public knowledge institutions, Van Beers et al. (2008) studied small economies (The Netherlands and Finland) and found that in The Netherlands foreign firms were less involved in cooperating with public knowledge institutions than domestic firms were whereas the opposite occurred in Finland. Both countries proved that spillovers have a positive effect on the probability of cooperating with universities and public knowledge institutions. That aspect was highlighted as having a positive impact on company innovation and R&D.

Taking the above into account, the following hypotheses are proposed:

H1: In a localized business network environment, as concerns R&D activities inter-company relations and company-institution relations have a positive impact on each company's innovation (product, process and administrative innovation).

H2: In a localized business network environment, as concerns R&D activities inter-company relations and company-institution relations have a positive impact on each company's R&D activities (input for innovation).

In business network exchanges, TKT is fundamental to disseminating and absorbing innovations (Banyte & Salickaite, 2008); therefore, it is fundamental to a company's innovation performance (Arvanitis et al., 2007; Capello, 2002; Evangelista et al, 1997; Lin & Chen, 2006). Furthermore, it contributes to each company increasing its R&D activities, creating its own innovations, and decreasing its dependence on ideas and technologies developed by others (Rammer & Schmiele, 2007). The literature on TKT refers to formal and informal exchanges (Allen et al., 2007) that take place among the personnel of the companies and institutions that are part of the network. That aspect constitutes relational capital (Capello, 2002; Capello & Faggian, 2005).

TKT has been studied as technology acquisition (Bin, 2008) or as the absorptive capability for technology (Fabrizio, 2009). Nevertheless, it is worth considering that TKT is not always the product of strictly commercial transactions; TKT occurs by employing diverse strategies in the form of joint research projects (or technology development projects), joint training projects (Arvanitis et al., 2007) or mutual support contracts for innovation in companies where public institutions play an important role. TKT also occurs in the joint use of technical infrastructure and laboratories, among others (Arvanitis et al., 2007; Filatochev et al., 2003).

Some empirical papers illustrate how inter-company TKT in localized networks influences company innovation and R&D activities. Capello (2002) found that scientific knowledge spillovers generated by universities and R&D centers influence business innovation activities. Small firms in non-urban areas use that knowledge in particular to the best advantage given such companies' production specialization. Lin & Chen (2006) evidenced that industry network knowledge integration has a positive effect on the process of developing new products.

By studying two Spanish clusters, Martínez & Céspedes (2006) found that companies used their relation with regional associations to obtain knowledge that contributes to their capabilities, even though there was no significant relation with innovation per se. Arvanitis et al. (2007) found that business innovation development indicators had a positive relation with TKT although at different levels of significance; process innovation and product innovation presented the best results in terms of the relation considering public research organizations. Knudsen (2007) found that inter-company relations had an effect on the success of new product development in the form of more frequent customer participation. He also found that companies had a tendency to make alliances with other companies in the same industrial sector and mentioned the danger that that involves. Indeed, he argued that the knowledge contributed was similar; therefore it hindered the possibility of developing radical product innovations. He further found that customer, university and competitor participation had a significant negative influence on innovation development, which he defined as an apparent paradox[3]. Finally, he concluded that the set of supplementary and

[3] There are two explanations for this apparent paradox: 1) average customers are incapable of articulating their needs regarding advanced technology products and 2) average customers are incapable of conceiving ideas beyond their own experience (Knudsen, 2007, pg.117).

complementary knowledge with external partners for new product development has a positive effect on innovative performance. Based on the above, the following hypotheses are proposed:

H3: In a localized company network environment, inter-company and company-institution technology and knowledge transfer has a positive effect on company innovation (product, process, administrative innovation).

H4: In a localized company network environment, inter-company and company-institution technology and knowledge transfer has a positive effect on company R&D activities (input for innovation).

5. Methodology

The empirical studies reviewed above regarding the topic of business networks show the wide variety of technologies and techniques available for use (Vom Hofe & Chen, 2006 and Wolfe & Gertler, 2004). Dhose and Soltwedel (2006) drew a similar conclusion upon reviewing the papers presented in the Workshop on Spatial Econometrics in April 2005. Those authors stated that the topics of the most important papers presented – which analyzed what they called "innovation clusters" – had very different points of view and employed very different methodologies.

Nevertheless, there are papers that classify research into certain typologies of techniques. One of them is the classification established by the OECD team specialized in industrial clusters; it identifies five categories of analysis techniques: input–output tables, the innovation interaction matrix, the graph theory (or network analysis), the correspondence analysis (quantitative studies that use statistics and econometrics techniques), and case studies (OECD, 1999b). Wolfe and Gertler (2004) proposed three methodology perspectives for studying clusters: statistic analysis tools with different levels of sophistication for measuring the degree of grouping in a local or regional economy, case studies for an comparative analysis of an individual cluster or a comparative analysis of a group of clusters, and the analysis of public policy and strategies specifically designed for promoting the establishment and growth of a cluster or of a group of clusters in a location or region. This last methodology is frequently combined with quantitative studies and case studies.

Based on the above, to establish the methodology to be used in this work, the author analyzed 64 empirical studies and found that the various authors had used one of the three methodologies mentioned above. Table 1 presents a summary of the methodologies most commonly used in the mentioned analysis.

The table above shows a general tendency towards using combined methodologies, seen in 47% of the studies reviewed, 20% of which used the combination CA– CS that implies combining the data (qualitative and quantitative) obtained through field work. Combining techniques can lead to a more in-depth analysis of the set of events and phenomena that take place in business networks and that cannot be successfully explained by data gathered from secondary sources, which is common in studies that solely use correspondence analysis (quantitative studies). To be consistent with the literature on the topic, the analysis

in this article combines case studies with quantitative techniques to understand gathered data.

METHODOLOGY USED	THEORETICAL APPROACHES IN THE ANALYSIS OF BUSINESS NETWORKS						TOT.	%
	AGGLOMERATION ECONOMICS		CLUSTER AND INDUSTRIAL DISTRICTS		NETWORKING			
	#	AUTHORS	#	AUTHORS	#	AUTHORS		
ONLY CA	8	Alecke et al., 2006; Alonso-Villar et al.,2004; Blasio & Di Addario, 2005; Callejón, 1998; Ciccone, 2001; Feldman & Audretsch, 1999; Le Bass & Miribel, 2005; Viladecans-Marsal, 2004	3	Baptista & Swann, 1998; Beaudry & Breschi, 2003; McDonald et al., 2006	2	Hagedoorn & Duysters, 2002; Minguzzi & Passaro, 2000	13	20,3
ONLY CE	1	Mun y Hutchinson, 1995	11	Eraydin & Amartli-Köroglu, 2005; Feldman et al., 2005; Heath, 1999; Khan & Ghani, 2004; Lagendijk & Charles, 1999; Nadvi, 1999; Nadvi & Halder, 2005; Nassimbeni & Sartor, 2005; Perdomo & Malaver, 2003; Power & Lundmark, 20004; Vega-Rosado, 2006	8	Benson-Rea & Wilson, 2003; Biggiero, 2001; Carbonara, 2002; Huggins, 2000; Lechner y Dowling, 2003; Pöyhönen y Smedlund, 2004; Steinle et al., 2007; Yogel et al., 2000	20	31,2
OTHERS					1	Beesley, 2004	1	1,5
I/O – GT			1	Hauknes, 1999			1	1,5
I/O – CA	1	Trueba y Lozano, 2001	1	Vom Hofe & Bhatta, 2007			2	3,1
I/O – CE			4	Bishop et al., 2000; Chaminade, 1999; Oliveira & Fensterseifer, 2003 ; Roelandt et al., 1999;	1	Marceu, 1999	5	7,8
GT – CA					1	Giuliani, 2007	1	1,5
GT – CE					2	Macías, 2002; Carrasco & Albertos, 2006	2	3,1
CA – CE	4	Gordon & McCann, 2000; O'Donoghue y Gleave, 2004; Tuan & Ng, 2001; Zheng, 1998	6	Hervás et al., 2007; Hu et al., 2005; Lai et al., 2005; Mezquita & Lazzarini, 2006; Nassimbeni, 2003; Oyelaran-Oyeyinka & Lal, 2006	3	Bell, 2005; Malewicki, 2005; Mas-Ruíz, 2000	13	20,3
OTHER COMBINATIONS	4	Black et al., 2004; Davis & Weinstein, 1999; Frenken et al., 2005; Rosenthal y Strange, 2003			2	Johannisson & Ramirez-Pasillas, 2002; Reid et al., 2007	6	9,3
TOTAL	18		26		20		64	100

I/P: Input – output; GT: Graph theory; CA: Correspondence analysis; y CE: Case studies

Table 1. Summary of the Methodologies Used, by Theoretical Approach

5.1 Population and sample

The study consisted of 101 companies in the tools manufacturing sector (ISIC[4]); they represent the total population in the Provincial Department of Caldas in Colombia. The information was obtained from the Manizales Chamber of Commerce (CCM is the Colombian acronym), the Colombian National Industrialists Association (Asociación Nacional de Industriales - ANDI), the Colombian Small Industrialists Association (Asociación Colombiana de Pequeños industrials - ACOPI) and the Manizales telephone directories. Those databases were compared, to obtain the population under study. The population is distributed in three links of the tool cluster value chain: suppliers, core companies (tool manufacturers), and customers. Among those companies, 90% are micro-companies or small companies and 97% of them are part of forward and backward linkages, which enabled analyzing the networks and identifying their impact on the link nucleus (see Table 2).

FEATURES	(%)
Type of link	100
Suppliers	36
Main companies	3
Customers	61
Company size	100
Micro	64
Small	26
Medium	4
Large	6

Table 2. Tool Cluster General Data

5.2 Measuring

The study involved four company factors: innovation (product, process and administrative innovations), R&D activities (experimental development, innovation projects, use of infrastructure), links for inter-company and company-institution R&D activities (experimental development, innovation projects, use of infrastructure), and technology and knowledge transfer (machinery and equipment, specialized software and technical information, and dissemination of research results). To adjust the models, the control variable *company size* (number of employees) was included. The dependent variables as well as the independent variables are dichotomic variables (Jensen, et. al. 2007; Knudsen, 2007; Rammer & Schmiele, 2009). They are defined and operationalized in Chart 1.

5.3 Validity and reliability

The instruments used in this research have been adapted from prior research papers (Capello, 2002; Capello & Faggian, 2005; Cassiman & Veugelers, 2002; Earydin & Amartli-Köroglu, 2005; Filatochev et. al., 2003; Jensen et. al. 2007; Johansson & Karlsson, 2007; OCDE/EUROSTAT, 2005; OCDE; 2002). However, to establish the validity and

[4] International Standard Industrial Code. This group manufactures knifes, hand tools and hardware store items.

VARIABLE	OPERACIONALIZATION
Business innovation	The company has made innovations (product, process, administrative) in the last five years. Yes 1, No 0
R&D in the company	The company carries out R & D (experimental development, innovation projects, use of infrastructure). Yes 1, No 0
Links for R&D	The company partners or partnering with other local actors to perform R & D (experimental development, innovation projects, use of infrastructure). Yes 1, No 0
Inter-company TKT	The company has or has had technology and knowledge transfer (machinery and equipment, specialized software and technical information and dissemination of research results) with other local. Yes 1, No 0
Company size	Number of employees

Chart 1. Variable Operacionalization

reliability of the instrument, the following analyses were made: content validity by experts on the topic and a pilot test involving ten companies; Cronbach's alpha, to evaluate instrument consistency and proposed dimension consistency, obtaining $\alpha>0.7$; and a correlation analysis, to establish convergent validity, obtaining significant correlations ($\rho<0.05$) and a concordant theoretical value ($\rho>0.7$) (Nunally, 1978). The above enabled establishing that the dimensions proposed for measuring inter-company business innovation, R&D activity links, and technology and knowledge transfer presented homogeneous measurements.

5.4 Comparison of hypotheses

First, a descriptive analysis was made in order to make an exploratory identification of the aspects related to the variables studied in the tool cluster. Also, a cluster analysis made with the maximum verisimilitude method using the criteria of "closest neighbor" and "unit of measure *lambda*, to identify the percentage of companies that develop innovations, by type of innovation (product, process and administrative). Based on the cluster analysis, a contingency analysis was made, to establish the realization indicator for the links defined in the independent variables, according to the cluster.

For comparing the hypotheses, a logistic regression analysis was made using the stepwise logistic regression method, considered appropriate for analyzing dichotomic variables, measuring impact, and adjusting variables. The Hosmer-Lemeshow test was run, to prove the specificity of the regression model. A linktest was run, to prove that the logit models are a linear combination of the dependent variables and independent variables. An analysis of estimated correlations was made, to determine that there was no correlation among the explanatory variables. And a marginal effect analysis was made, to establish incidence in terms of the probability of the independent variables / dependent variables.

6. Findings

First, the article presents a general profile of the sample companies according to study variables. The results indicate that 36% of the companies had developed innovations (product, process and administrative) and that 26% had carried out R&D activities; only 25% had links for the R&D activities and 38% had participated in technology and knowledge transfer (see Tables 3 and 4).

Business innovation	Inter-company TKT	
	NO	YES
NO	54%	10%
YES	8%	28%

Business innovation	Links for R&D	
	NO	YES
NO	62%	2%
YES	13%	23%

Table 3. Contingency Analysis among Business Innovation, Inter-company TKT, and Links for R&D

R&D in the company	Inter-company TKT	
	NO	YES
NO	56%	18%
YES	6%	20%

R&D in the company	Links for R&D	
	NO	YES
NO	68%	6%
YES	7%	19%

Table 4. Contingency Analysis among R&D in the company, Inter-company TKT, and Links for R&D

For the purpose of determining company behavior regarding the variable "innovation" considering the three types of innovation studied, a hierarchical cluster analysis was made, using as a reference the "closest neighbor" categories and *Goodman and Kruskal's lambda*[5] as measurement interval, the latter commonly used for dichotomic variable analysis. That led to identifying two types of business conglomerates in the population, according to the innovation.

The first type was comprised of 79 companies with low levels of process innovation and administrative innovation and with no product innovation; it was called low innovation level conglomerate. The second type was comprised of 22 companies with a high level of process innovation (77%), administrative innovation (50%), and product innovation seen in all of the companies; it was called high innovation level conglomerate (see Figure 1 and table 5).

TYPES OF BUSINESS INNOVATION	**CONGLOMERATE 1**	**CONGLOMERATE 2**
process Innovation	0,1	0,77
product innovation	0	1
organizational Innovation	0,08	0,5

Table 5. Business Innovation Conglomerates

[5] This type of interval is used taking into account that the analysis variables are dichotomic.

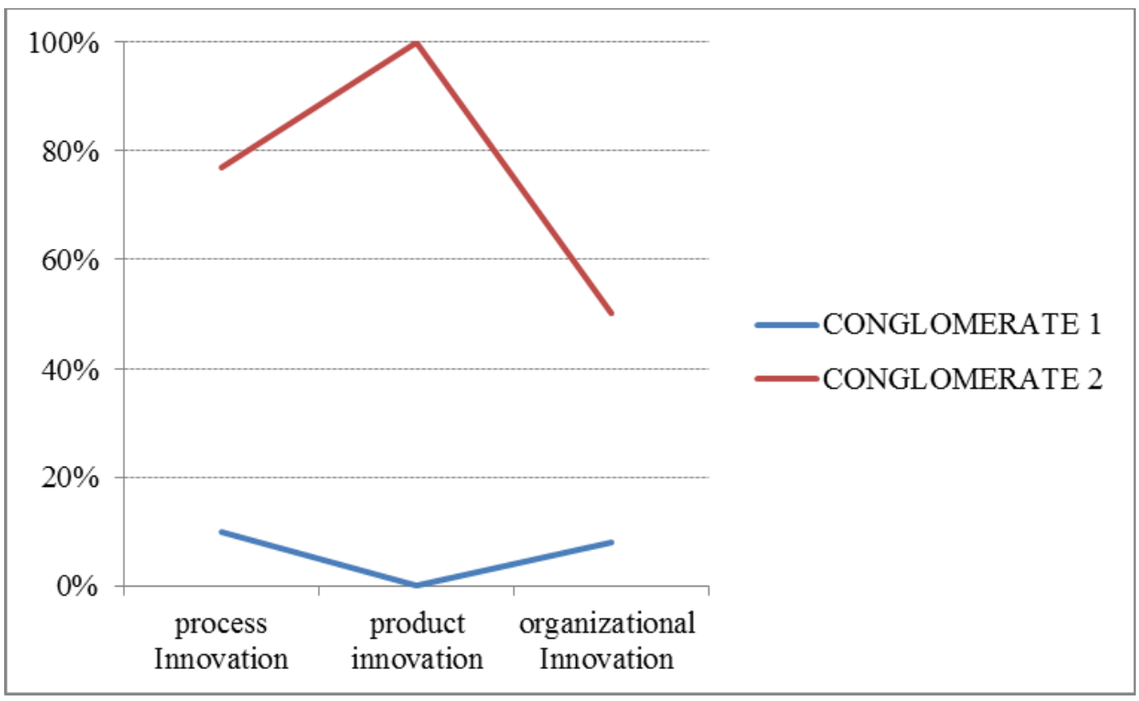

Fig. 1. Business Innovation Conglomerates

Using the data above and through a contingency analysis, the high innovation level conglomerate (Conglomerate 2) presents a higher inter-company association index for R&D activities (86%) and a higher TKT index (95.5%) than the low innovation level cluster (Conglomerate 1) (see Table 6).

INDEPENDENT VARIABLES	CONGLOMERATE 1	CONGLOMERATE 2
Links for R&D	7.6%	86.4%
Inter-company TKT	21.5%	95.5%

Table 6. Contingency Table of Innovation conglomerates and Links for R&D and inter-company TKT

To compare the hypotheses, a logistic analysis was made. For the first two hypotheses, the author studied the incidence of inter-company and company-institution cooperation on carrying out R&D activities for business innovation (H1) and on each company's R&D activities (H2). For the third and fourth hypothesis, the author studied the effect of inter-company and company-institution technology and knowledge transfer (TKT) on business innovation (H3) and on each company's R&D activities (H4).

The results showed that both H1 and H2 have a positive significant effect ($p\ value < 0.001$); such findings validate accepting both of those hypotheses. Likewise, both H3 and H4 have a positive significant effect ($p\ value < 0.001$), which means that they can be accepted (see Table 7 and 8).

Variables	BUSINESS INNOVATION								
	Model 1			Model 2			Model 3		
	β	Z	Sig.	β	Z	Sig.	B	Z	Sig.
Control Var.									
Constant	-1,440441	-4,36	***	-1,990311	-5,31	***	-2,167	-5,09	***
Size	0,0611753	2,53		0,025925	1,48		0,03373	1,38	
Dependent Variable									
Links for R&D				3,748522	4,54	***			
Inter-company TKT							2,39628	4,28	***
Lr χ2	26,5		***	58,77		***	47,05		***
Pseudo R2	0,2014			0,4467			0,3576		
Goodnes fit				57,4			76,86		

Table 7. Logistic Regression Analysis for the Tool Business Network – Business innovation

Variables	R&D IN THE COMPANY								
	Model 1			Model 2			Model 3		
	β	Z	Sig.	β	Z	Sig.	B	Z	Sig.
Control Var.									
Constant	-1,852675	-5,52	***	-2,847551	-5,63	***	-2,4315	-5,46	***
Size	0,0401128	2,42	*	0,020963	1,5		0,02583	1,71	…
Dependent Variable									
Links for R&D				3,318111	4,85	***			
Inter-company TKT							1,64242	2,77	**
Lr χ2	27,31		***	55,41		***	35,33		***
Pseudo R2	0,2371			0,481			0,3067		
Goodnes fit				46,18			41,78		

Table 8. Logistic Regression Analysis for the Tool Business Network – R&D in the company

To complement the analyses above, a marginal effect analysis was made, to establish to what degree association for R&D and TKT activities affects business innovation and company R&D activities. On one hand, the analysis showed that a percentile increase in inter-company and company-institution cooperation for carrying out R&D activities

generates an increase of 0.68% in innovation and an increase of 0.66% in each company's R&D activities. On the other hand, a percentile increase in inter-company and company-institution TKT generates an increase of 0.53% in innovation and an increase of 0.35% in each company's R&D activities. Upon comparing those results with the pseudo-coefficient of determination, the conclusion may be drawn that the models in which there is inter-company and company-institution cooperation for carrying out R&D activities present a greater fit than the models in which the variable inter-company and company-institution technology and knowledge transfer (TKT) is present (see Table 9).

VARIABLES	Business innovation		R&D in the company	
	δy/δx	Sig.	δy/δx	Sig.
Links for R&D	0.68%	***	0.66%	***
Inter-company TKT	0.53%	***	0.35%	**

** *p value* <0,01; *** *p value* <0,001

Table 9. Marginal Effects of the Independent Variables on Company R&D Activities and on Business Innovation

The results obtained from applying the logit model as discussed above were tested, to verify the goodness of fit. To do so, the level of significance[6] was identified for the model and Wald's linearity analysis parameters[7] were applied, plus an error term distribution analysis[8] was made. Likewise, the non-existence of multicolinearity and heteroskedacity was identified.

7. Discussion and conclusions

Upon reviewing the literature that studies inter-company and company-institution relations, three main theoretical approaches were studied (agglomeration economies, clusters and industrial districts, and networking), which have guided the research on such relations and that, given the convergence in the theoretical orientation of such approaches, as well as the perspective employed in each research paper, the notion of "business networks" can be understood as the common unit of analysis. In that sense, the conclusion can be drawn that there is a consensus in the literature on the topic regarding the positive effect of inter-company and company-institution relations in a network environment on business performance, especially because they result in greater possibilities of knowledge development, broadened company's innovation process capabilities, and better results in process, product, and administrative innovations.

There was evidence in the tool cluster in the Provincial Department of Caldas in Colombia that the percentage of companies that have developed innovations and carried out R&D

[6] The Lr χ^2 *(p value < 0.001)* test was run.

[7] The parameters were identified as being linear and consistent (*p value>0.05).*

[8] The Roc Curve Graph was prepared and the sensitivity and specificity graphic analysis was made, as well as the Hosmer-Lemeshow test (*p value>0.001)* that proves the non-existence of stochastic perturbations.

activities is relatively low and, therefore, the author observes that the percentage for establishing relations for R&D and TKT is also low. That fact can be explained by the composition of the companies. Indeed, most fall into the category of SMEs with limited capabilities for carrying out those types of activities, as well as for establishing contacts with other regional stakeholders. Mahemba & De Bruijn (2003) found a similar situation in Tanzania; their explanation was that SMEs are not aware of opportunities in their midst, such as collaboration with research institutes, universities, technology centers, and the government. Nevertheless, that contradicts the findings of Barge-Gil (2009) who proposes that small firms and firms in low, medium-low, and medium sized sectors are more prone to innovation-based cooperation; he further highlights the role that suppliers play in innovation development.

The companies that stated that they had relations with other stakeholders enabled comparing the proposed hypotheses and, hence, enabled proving that inter-company relations and relations between companies and other regional stakeholders for R&D and TKT have a positive effect on the company's R&D and innovation. Therefore, the proposed hypotheses may be accepted. That fact corroborates other findings in the literature on the topic.

In general, the results obtained are consistent with the idea of "relational capital" (Capello, 2002; Capello and Faggian, 2005); nevertheless, they leave unanswered questions that may be addressed in future research. One practical suggestion for future research would be to study, in the business network under study herein, the determinants that influence the companies' low propensity to establish relations with other regional stakeholders in order to improve business innovation and even to observe other variables associated with the innovation process (Arvanitis *et al*., 2007) that may affect business innovation. Another future line of research may involve conducting similar inquiries in other business networks and in other geographical environments and then carrying out comparative analyses. It would be particularly interesting to study the relation between companies and support institutions (governmental and non-governmental) as that is a fundamental aspect for public policy regarding business competitiveness and regional social and economic development in countries such as Colombia.

Finally, the author proposes some other future lines of research to complement this article. Studies may be conducted inquiring what variables are the most determinant for the integral development of business networks, for example, employment is often used to evaluate productive specialization, competences or technological innovation. Yet another suggestion would be to identify the geographical contexts and sectors in which the research is focused and carry out comparative analyses.

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It is widely accepted that technology is one of the forces driving economic growth. Although more and more new technologies have emerged, various evidence shows that their performances were not as high as expected. In both academia and practice, there are still many questions about what technologies to adopt and how to manage these technologies. The 15 articles in this book aim to look into these questions. There are quite many features in this book. Firstly, the articles are from both developed countries and developing countries in Asia, Africa and South and Middle America. Secondly, the articles cover a wide range of industries including telecommunication, sanitation, healthcare, entertainment, education, manufacturing, and financial. Thirdly, the analytical approaches are multi-disciplinary, ranging from mathematical, economic, analytical, empirical and strategic. Finally, the articles study both public and private organizations, including the service industry, manufacturing industry, and governmental organizations. Given its wide coverage and multi-disciplines, the book may be useful for both academic research and practical management.

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