



EVALUATING R&D NETWORKING TO REVITALIZE SMES INNOVATIVE PERFORMANCES: A MANAGEMENT PERSPECTIVE

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Abstract. This research provides new evidence on the relationship concerning R&D networking decisions and firms' competitiveness in a local SMEs entrepreneurial system. The role of R&D linkages on the firm's productivity drivers and innovation processes is investigated and tested. Next, some empirical evidence, obtained by using detailed and specific survey-based data on 63 Italian SMEs, is presented. I find that R&D networking (R&D partnerships and agreements) has a moderate impact on the SMEs' productivity and a strong impact on the innovation processes. Finally, in order to provide some practical implications based on this moderate finding, I present a R&D model to support the competitiveness of SMEs located in peripheral districts.

Keywords: R&D linkages, network, firms' performances, productivity, innovation processes.

JEL Classification: M19, M29.

MOKYMO BEI MOKSLINIŲ TYRIMŲ IR VYSTYMO INFRASTRUKTŪROS TYRIMAS SMULKIOJO IR VIDUTINIO VERSLO ĮMONIŲ INOVATYVIOS VEIKLOS SKATINIMO POŽIŪRIU: VALDYMO PERSPEKTYVA

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Santrauka. Straipsnyje pateikta naujų įrodymų apie santykius, besiklostančius priimant sprendimus mokymo bei mokslinių tyrimų ir vystymo infrastruktūroje, įmonių konkurencingumą smulkiojo ir vidutinio verslo sistemoje vietiniu lygmeniu. Išanalizuota ir įvertinta mokymo bei mokslinių tyrimų ir vystymo infrastruktūros sąsaja su įmonės produktyvumu ir inovacijų procesais. Be to, pateikti apibendrinti rezultatai empirinių tyrimų, atliktų remiantis 63-įjų smulkiojo ir vidutinio verslo Italijos įmonių veiklos duomenimis. Prieita prie išvados, kad mokymo, mokslinių tyrimų ir vystymo infrastruktūra turi ne tokį stiprų poveikį smulkiojo ir vidutinio verslo įmonių produktyvumui, palyginti su poveikiu inovacijų procesams skatinti. Atsižvelgiant į tokias išvadas, siūlomas mokymo, mokslinių tyrimų ir vystymo infrastruktūros modelis remti smulkiojo ir vidutinio verslo įmonių konkurencingumą vietiniu lygmeniu.

Reikšminiai žodžiai: mokymo, mokslinių tyrimų ir plėtros susitarimai, infrastruktūra, įmonių konkurencingumas, įmonių produktyvumas, inovacijų procesai.

1. Introduction

The role of cooperative R&D in the improvement of firm competitiveness has been an issue of increasing interest that has been extensively explored in the management literature of recent decades (Das, Teng 2000; Arora, Gambardella 1990; Basile 2011; Hagedoorn 2002). The main reasons for that interest lie in the intensity and increasing competition and cooperation worldwide due to globalization and internationalization trends.

Entrepreneurial competencies and firms' internal resources are seen to be insufficient to achieve greater economies of firm, to reduce the levels of uncertainty involved to compete in local and international markets and to exploit new business opportunities (D'Aveni *et al.* 2010). In the last decade it has been largely accepted that the specific knowledge is a core driver behind the emergence of a new architecture of relationships to create firm's innovativeness (Liebeskind *et al.* 1996; Powell *et al.* 1996).

For these reasons, collaborative processes are considered a correct strategy to improving performance levels in the case of small and medium firms or SMEs.

To have access to new information and knowledge is one of the most motivations behind cooperation between firms. If innovation is considered as a social and interactive process, it generally involves a variety of actors and - for this reason - the role of external actors acquires a higher importance. Therefore, it is largely accepted that both competing and cooperating relationships involve key factors in the enhancement of firms' competitiveness levels (Lundvall 1992).

The main research result extracted from the empirical evidences is that collaborative networking may increase firms' competitiveness, chiefly favouring productivity and innovation in the SMEs. Although it is agreed that the Italian case has been paradigmatic, other experiences are reported for other European cases, as well as for North America and Japan. In addition, management analysis has tried to explain how R&D collaboration strategy affects a firm's decisions to improve innovation processes and firms' productivity.

The key driver whether cooperative R&D has the expected positive impact on SMEs' (innovation) performance and productivity has remained partly unexplored by the management literature (Das, Teng 2000). A number of research articles have included a cooperation variable in empirical models explaining differences in firms' innovation processes (Klomp, van Leeuwen 2002), but most of these studies have been primarily concerned with the impact of R&D investments on performance, large firms' impact and with labour productivity. At the same time management studies have restricted their analyses to particular performance indicators in specific high-tech industries (e.g. the effect of alliances on high-tech start-up firm performance in the biotech industry, Baum *et al.* (2000), Powell *et al.* (1996), Liebeskind *et al.* (1996), or to the effect of learning

in alliances on market share performance in the global automotive industry. Research has not examined systematically differences in impacts across R&D cooperation types, R&D cooperative networking in small firms and R&D networking impact on both innovation processes and productivity simultaneously.

The following analysis, instead, exploits data from a local economic system composed of manufacturing and market service firms, where small and medium enterprises (SME) are dominant and synergies bet R&D networking as a driver of firms' competitiveness.

Secondly, the relationship between R&D networking and firms' competitiveness (productivity and innovation processes) is tested; finally, I present a new R&D networking model to support SMEs' activities.

In this work I attempt to offer some empirical evidence to better understand if and how R&D networking in a peripheral area can influence SMEs' performance and development.

The issue is analyzed from the perspective of the strategic implications for 63 SMEs located in Sicily, and the survey is designed to define bottom-up entrepreneurial implications on R&D decision-making.

The remainder of the paper is organized as follows: Section 2 provides an overview of the previous theoretical literature discussing the impact of R&D networking (cooperation) on SMEs. Section 3 provides theoretical and empirical literature about the impact of R&D networking on the firm's innovation processes and productivity. Section 4 describes the empirical model and data. Section 5 discusses the empirical results. Section 6 presents a new R&D networking model for support of SMEs activities. Finally, some conclusions are drawn in Section 7.

2. The Networking in SMEs: literature background

Small and Medium-sized enterprises play a central role in the economic development of any territory and regional economic systems (Faraci, Shillaci 2002).¹

The driving force of innovation and productivity is learning, both at the organizational and at the intellectual human capital level (Zucker *et al.* 1998; Davenport 2002). Accordingly, as Powell *et al.* (1996) suggest, the locus of competitiveness may be found in inter-organizational collaboration rather than in firms.

Empirical researches has shown that The increasing costs of R&D in combination with a shortening of product

¹ Several authors shown: "SMEs seem to be the appropriate agents to behave like collaboration nodes because of their lean structure, adaptability to market evolution, active involvement of versatile human resources, ability to establish sub-contracting relations and good technological level of their products. In light of the above, SMEs have advantages in terms of flexibility, reaction time, and innovation capacity, which makes them central actors in new economies."

and technology lifecycles, blurring industry boundaries in a dynamic technological environment and an improving international competitiveness, have made it almost impossible to develop innovation and technology on a stand-alone basis. Actors, especially small firms use these collaborations to reduce costs of R&D, to transfer technology in order to improve innovative performance, to reduce time-to-market or to search for new business opportunities².

With regard to the management perspective, the view prevails that the locus of innovation and productivity performance is in networks of inter-organizational relationships (networking) focused on R&D strategic agreements (Basile 2011) divides non-internal R&D activities into two categories: external (licensing, R&D contracts, outsourcing, customer-supplier relationship) and quasi-external (strategic alliances).³

Although it has been noted more generally that a great share of alliances fail, R&D alliances may be a source of competitive advantage and have long lasting effects on firm performance.⁴

In other words, a certain level of competitiveness may be felt as a prerequisite for a SME's survival when dealing with dynamic business conditions. To compete with global adversaries and overcome rapid technological changes as well as product variations, SMEs must be able to accomplish effective innovation processes. In effect Dickson and Hadjimanolis (1998) state that since small companies typically lack some of the core resources for innovation, they have to acquire them from external sources such as other firms, technical institutions or actor providers.

R&D networking offers (especially to SMEs) a change to global growth, which would be otherwise impossible or remarkably difficult. There are several ways to grow through R&D networking. In one case, companies – SMEs – with their own products can operate in global markets focusing on their core business and co-operating with module design partners.

To summarise, with regard to the relationship between networking and firms' performance, the majority of research highlights the role of individuals and more specifically the importance of R&D networking for the diffusion of innovation processes⁵. However, while the utility of R&D agreements and collaboration for enhancing the development of innovations and innovation diffusion is well-established, there appears to be a need for more focussed research on the impact of networking on the development and diffusion of different forms of innovation (e.g. product, process and organisational)⁶. Research has evidenced that some SMEs benefit from cooperation for their innovation processes, whereas others experience major problems. The positive effects include increased turnover, higher profit rates and expansion of the product range. However, SMEs often find it difficult to establish and benefit from inter-organizational innovation projects. One of the reasons is that smaller companies cannot enforce their will upon others. The distribution of the results is therefore a key issue for them.

The literature evidences show a number of key points for SMEs:

1. The type of R&D networking, different kinds of linkages and its utility for innovation and competitiveness depends on the strategic requirements of the individual actors (Powell *et al.* 1996);
2. R&D Networking formation often differs among different forms of innovation required by actors; networks for product innovation are different from networks for process innovations;
3. The substance of a firm's R&D alliance network during formation can have important ramifications for future innovation processes and productivity performance (Baum *et al.* 2000);

² For a more elaborate overview, see e.g. Hagedoorn (1993).

³ Das, Teng 2000 explain: "Explanations for collaborative R&D that have been extensively discussed revolve around factors such as sharing risks and costs in the face of uncertain technological developments showing economies of scope and scale or synergistic effects through efficient pooling of the firms' resources, learning through monitoring technology and market developments, dealing with regulations and industry standards, and responding to government subsidy policies."

⁴ Dickson and Hadjimanolis 1998 examined SMEs' performance and R&D networking among small manufacturing companies explain "We found some tentative evidence that companies operating in terms of "the local strategic network" are more innovative than those operating in terms of "the local self-sufficiency". The typical Taiwanese or Chinese production system is a cooperative network of SMEs that are extremely flexible and respond quickly, though under-capitalized, and sensitive to market demand, besides being highly integrated in the global economy. Strategic alliance formation has been touted as one of the most critical strategic actions that SMEs must undertake for survival and success."

⁵ Studies of R&D networking in particular have identified specific conditions under which collaborative arrangements are most beneficial. Powell *et al.* (1996) conclude "R&D consortia are advantageous when the knowledge base of an industry is both complex and expanding, the sources of expertise are widely dispersed, and the pathways for developing technology are largely uncharted. They argue that under these conditions, the locus of innovation will be found in networks of learning, rather than in individual firms, as in the case of the biotechnology sector. "A key finding from a diverse set of studies is that R&D intensity or the level of technological sophistication in industries is positively correlated with the intensity and number of alliances in those sectors."

⁶ The literature on network formation and networking activity therefore clearly demonstrates that whilst firms collaborate in networks for many different reasons the most common reason is to gain access to new or complementary competencies, technologies and markets. Liebeskind (1996) explains "There are several reasons why new SMEs firms may heavily depend on interorganizational system. The first reason is an access to knowledge. External collaborations ensure obtaining relevant, reliable and novel knowledge. These characteristics are of crucial importance for the biotechnology industry. The second reason is that optimization (reduction) of costs as collaboration may reduce the amount of sunk costs. Third, social networks may provide "more protection against appropriation than market, where even legal contracting may not prevent misappropriation".

4. All types of networking constantly change and adapt depending on the requirements and ties of partners and the context within which the collaboration process operates.
5. Both in R&D networking and business networking, science/providers firms play a role of interface for innovation processes. However, finding appears to be mixed with some evidence for against their role to promote R&D networking success (Phillmore 1999).

3. Firms performance: innovation processes and productivity

Scientific literature shown that In order to implement a good collaborative management strategy in SMEs, cultural, behavioural, and organizational issues need to be tackled before even considering technical problems. The importance and the difficulties of the R&D networking decision for innovation have been particularly emphasized in the case of SMEs. As they suffer more from material constraints, small and medium-sized firms are less able to innovate by themselves, and thus networking is vital. The empirical literature, however, does not clarify whether the general relationship between networking and innovativeness holds true for such companies. Analyzing over 1,600 Spanish manufacturing firms, Oliver and Erbers 1998B) find that size has a positive and significant effect upon R&D cooperation, since large companies enjoy more absorptive capacity.

Management literature showed certain evidences, with respect both to their effects on firm performance (productivity) and to the innovation performances. We refer to Powell *et al.* 1996, who focus on techno-organizational factors, organizational bundles and firm innovation performances. Researches provide other evidence on the EU arena, focusing on manufacturing firms, with a focus on the heterogeneity in R&D cooperation strategies by firm typology and sector, networking between firms and universities, internal R&D and external knowledge acquisition; Basile (2011) shows the role of Science partner as R&D networking provider for firm's competitiveness.

There is further empirical literature examining the sources of productivity growth and in particular, the role of inter-firms networking (e.g. Adams, Jaffe 1996; Basile and Cappello 2012; Coe, Helpman 1995; Basant, Flikkert 1996). These studies have generally confirmed that collaborative networking that may arise from interaction with other firms through international trade, foreign direct investments, and input-output linkages, has a positive impact on productivity growth. Similarly, empirical studies have documented the positive impact of the R&D on productivity at the firm level (e.g. Grilliches, Mairesse 1984; Lichtenberg, Siegel 1991).

In these studies, large firms are generally found to be more productive than their local industry competitors,

which are attributed to MNEs efficient exploitation of firm-specific assets allowing for multi-plant economies of scale and the transfer of accumulated tacit and specialized knowledge on production.⁷

I explore empirically the effect of R&D cooperation and agreements on one type of productivity performance, the growth in sales of innovative products that are new to the market per employee ('innovative sales productivity').

A number of empirical studies have found a positive impact of engaging in R&D cooperation on innovation performance (Liebeskind *et al.* 1996; Baum *et al.* 2000; Pittway *et al.* 2004). Research has evidenced that some SMEs benefit from cooperation for their innovation processes, The positive effects can include increased turnover, higher profit rates and expansion of the product range (De Jong, Vermeulen 2006).

However, networking can also be positively associated with innovativeness⁸. Several authors have argued that innovation processes start-up are the outcome of interactions between actors rather than the efforts of one firm in isolation (Lundvall 1992; Oliver, Erbers 1998). Networking between firms may augment the sharing and diffusion of technological knowledge, which thereby increases the innovative capability of such firms (Powell *et al.* 1996). Inter-firm cooperation in joint R&D, in particular, can permit companies to share the costs and risks of innovation. Networking can also allow firms a greater specialization of innovative labour.

A further innovation-linked reason for networking is that firms which possess accumulated capital (technological, commercial and social) enjoy advantages in the cooperation "market", as other companies view them as attractive potential partners (Ahuja 2000a, b).

At the same time, if there are unobserved firm characteristics that impact at the same time firms' incentives to cooperate and their innovative output, a positive correlation between cooperation and innovation may be spurious rather than causal (Klomp, van Leeuwen 2001).

In this work I predict a positive relationship between R&D networking and SMEs' competitiveness.

More specifically I propose:

H1: Innovation processes output is positively associated with R&D networking;

H2: Firm's productivity is positively associated with R&D networking.

Regarding the factors that linked R&D agreements to innovation process, according to the management litera-

⁷ The literature suggests: "An analysis of different types of cooperation strategies should take into account the different possible aims of (collaborative) R&D efforts. Labour productivity increases may be more reflective of incremental innovations and affected by collaborative R&D aimed at cost reductions, while sales expansion through innovative processes is more likely to be related to basic R&D efforts and client collaboration."

⁸ See Pittaway *et al.* (2004) for an excellent review.

ture I predict a positive link with: Science and Technology Linkages, R&D employees, Technology Innovativeness and Company Age.

Regarding the impact on the firm’s productivity (innovation sales products) I predict a positive link with: SMEs’ agreements, R&D expenditures/investments, market target and also logistics infrastructure accessibility.

A great range of scientific studies support the idea that the competitiveness of the firms depends on external drivers/resources: not only on the development and planning of networking system (Malecki, Tootle 1996; Basile 2011) and the existence of an innovative environment (Camagni 1991), but also on the existence of external infrastructures supporting entry mode to new businesses (Porter 1990). According to Maskell and Malmberg (1999), the competitiveness of industrial firms depends on a particular combination of local characteristics and external factors located in the productive district that influence the development of local SMEs of economic defining, a positive impact of logistics systems and infrastructures (i.e., airport proximity).

4. Data setting and method

The aim of this section is to provide a methodological framework to support the empirical test on the relationship between R&D networking and SMEs competitiveness such as innovation processes and productivity.

To test the hypotheses, a questionnaire was created. The survey was conducted between January and October 2010. Direct interviews were based on a semi-structured questionnaire. Interviews typically lasted from one half hour to one hour. Interviewees included the owners, chief executives and managers responsible for the decisions on the international processes of their firm.

The survey targeted potential respondents belonging to firms located in Sicily, an Italian region characterized by a wide range of industrial areas.

The research presents data from a survey of 63 SMEs, designed to define bottom-up managerial and entrepreneurial perspectives and implications. Empirical literature showed the positive impact of logistics systems and infrastructures (i.e., airport proximity) on the SMEs’ development. Firms were identified from lists obtained by industry and entrepreneur associations: Italian Chamber of Commerce, Confindustria Ragusa and the AIDA Bureau Van Dijk Database. The final survey participation count represents more than 57% of the original participation goal. Out of 100 total firms selected within those with at least 2.000.000 euro of revenues, 63 responded. The sample was consequently reduced on the basis of dimension (Revenues, SME with at least 6 employees, up to 250), industry (manufacturing and services sectors), international markets experience (exporters) and R&D efforts.

From a population of firms of 110 distributed among third isochronous catchment area, the sample size was calculated taking into account the following parameters:

- N = 110 (firms population)
- $\alpha = 5\%$ (the level of significance),
- $\varepsilon = 0.5$ (the precision error),
- $s^2 = 9.5$ (the pilot sample variance).

With (1) below, we obtained the sample size, which has to be stratified by the number of firms in Comiso area:

$$n = (z_{\alpha/2}^2 \cdot N \cdot s^2) / \varepsilon^2 \cdot (N - 1) + z_{\alpha/2}^2 \cdot s^2 = 63 \quad (1)$$

Having stratified proportionally (W_h) the sample distribution by firms in the reference population (N_h) we obtain the estimated number of firms to sample (n_h) (see Table 1).

Table 1. Stratified sampling proportional to firms

Isochronous	N_h	W_h	n_h
1° (within 30’)	66	60%	48
2° (31’–45’)	33	30%	12
3° (46’–60’)	11	10%	3
Total	110	100 %	63
f the sampling rate	57%		

where:

- N_h is the size of the h^{th} layer and H- the number of layers with $h = 1, \dots, H$ and $\sum_h N_h = N$;
- n_h ($\sum_h n_h = n$) the sample size in the generic layer h ;
- $f = n / N$ the sampling rate.

Three of the most common types of questions used in questionnaires or surveys are open-ended questions, closed-ended questions and Likert scales. An open-ended question does not provide the participant with a choice of answers. Instead, participants are free to answer the question in the manner they choose.

The Likert scale asks participants to provide a response along a continuum of possible responses. For example: Is it important whether the managers of the firm have R&D provider partner? (5) Strongly agree/high influence (4) agree (3) neutral (2) disagree (1) strongly disagree/no influence. Field survey, conducted via visits to the companies and interviews, aimed to verify the effectiveness of R&D networking defining strategic implications. To test the hypotheses, a logistic regression analysis was used, which is common in studies related to networking, strategic alliance value, firm’s competitiveness (Baum *et al.* 2000; Pisano 1990). Moreover, a logistic regression is the preferred choice when 1) the dependent variable is dichotomous; and 2) there is a combination of continuous or categorical independent variables (Pallant 2007).

A summary of the independent variables is presented in Table 1. The operationalization of their measures is illustrated in Appendix A. The appendix also lists the dependent variable, Y1 (Firm’s competitiveness – as IP (innovation

processes) COMP and P (productivity) COMP), which was assigned a value of 0 for a low (COMP) and 1 for a high degree of COMP).

5. Empirical evidence

I employed a logistic regression with a backward elimination approach for my analysis. Regression analysis is among the most commonly used statistical methods (Pope, Webster 1972), and logistic techniques are used when the outcome is in a binary form (e.g., competitiveness level). Prior to conducting the logistic regression, the correlation matrix of independent variables was created. This matrix provided no indication of multi-collinearity problems (Table 3). Further evidence of the lack of multi-collinearity was provided by the variable inflation factors (VIF). Indeed, in this study VIF score was between 1 and 2, which is very small and reduces the possibility of multi-collinearity (Pallant 2007).

Table 2 provides information about the contribution of each variable. The Wald Test was conducted to indicate the significance of each estimated coefficient, providing tests for the individual hypotheses. A positive coefficient in the regression represents a direct relationship between independent variables and entrepreneurial orientation to enter new markets, while a negative coefficient represents an inverse relationship. To develop a model with the best possible fit to the framework, I used backward elimination (p to move > 0.05) based on likelihood ratio estimates.

As illustrated in Tables 3, 4 and 5 on the next page, the hypotheses have been tested. An important result is that with regard to the impact of R&D linkages on the firms'

productivity, no statistical support was found. SMEs' agreements, R&D expenditures, market target are not related significantly to SMEs productivity. (sig. > 0.01 , 0.05). Company age and local logistics infrastructure accessibility have a moderate and significant impact (B 0.789 Sig. 0.049) and (B 0.569 Sig. 0.049).

Reversely to the literature, the empirical survey regarding Hypothesis H2 shows R&D networking does not affect firm's productivity.

In accordance with the predicted relationships deepened in the management literature, H1 is confirmed and statistically significant. These findings are consistent with other studies that find a strong link between R&D agreements and the start of innovation processes in SMEs.

6. A R&D networking model to revitalize innovative performances

Regarding data of SMEs' interviews and items, entrepreneurs and managers confirm the difficulties to engage in R&D agreement with other actors. SMEs often find it difficult to establish and benefit from R&D inter-firms linkages. SMEs involved in R&D cooperation are not necessarily more innovative (at least in the short time) than those involved in other types of cooperation, like subcontracting. I also find that companies engaging in R&D cooperation tend to have less extensive network relationships (i.e. they cooperate with local partners).

However, with regard to the impact on productivity, I find only weak results for differences between local and extra-regional R&D networking.

Table 2. Summary of independent variables

Hypotheses	Factors	Description
H1	Science and Technology linkages	R&D agreements (equity and no-equity) with Science and Technology provider such as Science and technology parks, hub R&D organization, Public Centre of technology transfer and other innovation network provider.
H1	R&D employees	Intellectual capital involved in the innovation processes.
H1	Technology innovativeness	Innovativeness level, degree of complexity and modularity of innovation outputs.
H2	SMEs' agreements	Type of external linkages (R&D contracts, subcontracting, horizontal link, partnership, strategic alliance, joint ventures, agreements with suppliers).
H2	R&D expenditures/investments	Amount of internal R&D financial efforts.
H2	Market target	Geographical market target, foreign markets, local business expansion.
H1-H2	Company age	Years of activities, business experience, internationalization experience.
H2	Infrastructure accessibility	Degree of accessibility (time, cost, financial efforts, distances), due at logistics infrastructure in the area. Role of the logistics infrastructures (In this work: airport's proximity).

While production subcontracting is the most common form of inter-firm cooperation, cooperation for technological innovation is the second most frequent form of cooperation in my sample.

In general, companies who collaborate in R&D do not choose R&D networking provider such as Science and Technology Parks, Business incubator and other R&D providers.

There is further empirical management literature which shows the positive role of R&D provider to improve innovation and competitiveness in SMEs (Basile 2011, 2012b, c; Phillimore 1999; Vedovello, Conceição 1997).

In this work, I present a new model of R&D networking for SMEs located in peripheral district. This model aims to revitalize firm competitiveness and support the effect of R&D collaboration strategy to improve productivity and to start new innovation processes in SMEs.

The R&D collaboration model is comprised of a set of SMEs whose main motivation for participating in a co-ope-

orative system is directly related to an increase in productivity (innovative sales productivity) and innovation processes. A R&D networking model provides a new innovation process produced by a set of partners, and this process or service is then captured by another set of partners in the collaboration system.

The R&D Net Mod usually has a strong hub-provider such as Science and Technology providers as Science and Technology Park who is the main source of value-creation lies and knowledge in the dynamic structure of the collaboration system and its ability to adapt to ever-changing market conditions (Ferguson, Olofsson 1998; Mäki 2002). In R&D networking process regarding peripheral district, science partners play an important role as independent provider and intermediaries within business and R&D collaboration; science partners act as intermediaries or neutral agents within the model enabling different business systems to communicate by generating trust between different SMEs. The evidence demonstrates that science

Table 3. Correlation matrix

Variables	VIF	H1	H2	H3	H4	H5	H6	H7	H8
Science and Technology linkages	1.31	1							
SMEs agreements	1.11	0.23*	1						
R&D expenditures	1.21	0.04**	0.23*	1					
R&D employees	1.34	0.04	0.01**	0.12*	1				
Technology innovativeness	1.27	0.03	0.02	-0.01	0.05	1			
Market target	1.34	0.01	0.03	0.12	0.06	0.21*	1		
Company age	1.19	0.11	0.07	0.31	0.02*	0.17	0.01**	1	
Infrastructure Accessibility	1.42	0.04*	0.08	0.45	0.37	0.09	0.03*	0.12	1

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Table 4. Model coefficient (H1)

	B	S.E	WALD	Df	p-value	Exp(B)
Science and Technology linkages	0.511	0.204	0.742	1	0.009	1.034
R&D employees	0.432	0.177	0.346	1	0.015	0.861
Technology innovativeness	0.321	0.219	2.536	1	0.045	0.651
Company age	0.389	0.517	0.388	1	0.031	0.675
Costant	-0.874	1.231	0.452	1	0,489	0.376

$p < .01$

$p < .05$

Model chi-square: 9.599 (Sig. 0.006).

-2 Log likelihood: 1,203.452

Table 5. Model coefficient (H2)

	B	S.E	WALD	Df	p-value	Exp(B)
SMEs' agreements	0.311	0.204	0.342	1	0.094	1.084
R&D expenditures	0.132	0.247	0,746	1	0.125	0.761
Market target	0.421	0.319	2.736	1	0.081	0.651
Company age	0.789	0.577	0.488	1	0.041	0.675
Accessibility infrastructure	0,569	0.371	1,629	1	0.049	0,723
Constant	0.674	1.435	0.652	1	0,619	0.816

$p < .01$

$p < .05$

Model chi-square: 7.519 (Sig. 0.089).

-2 Log likelihood: 1,403.122.

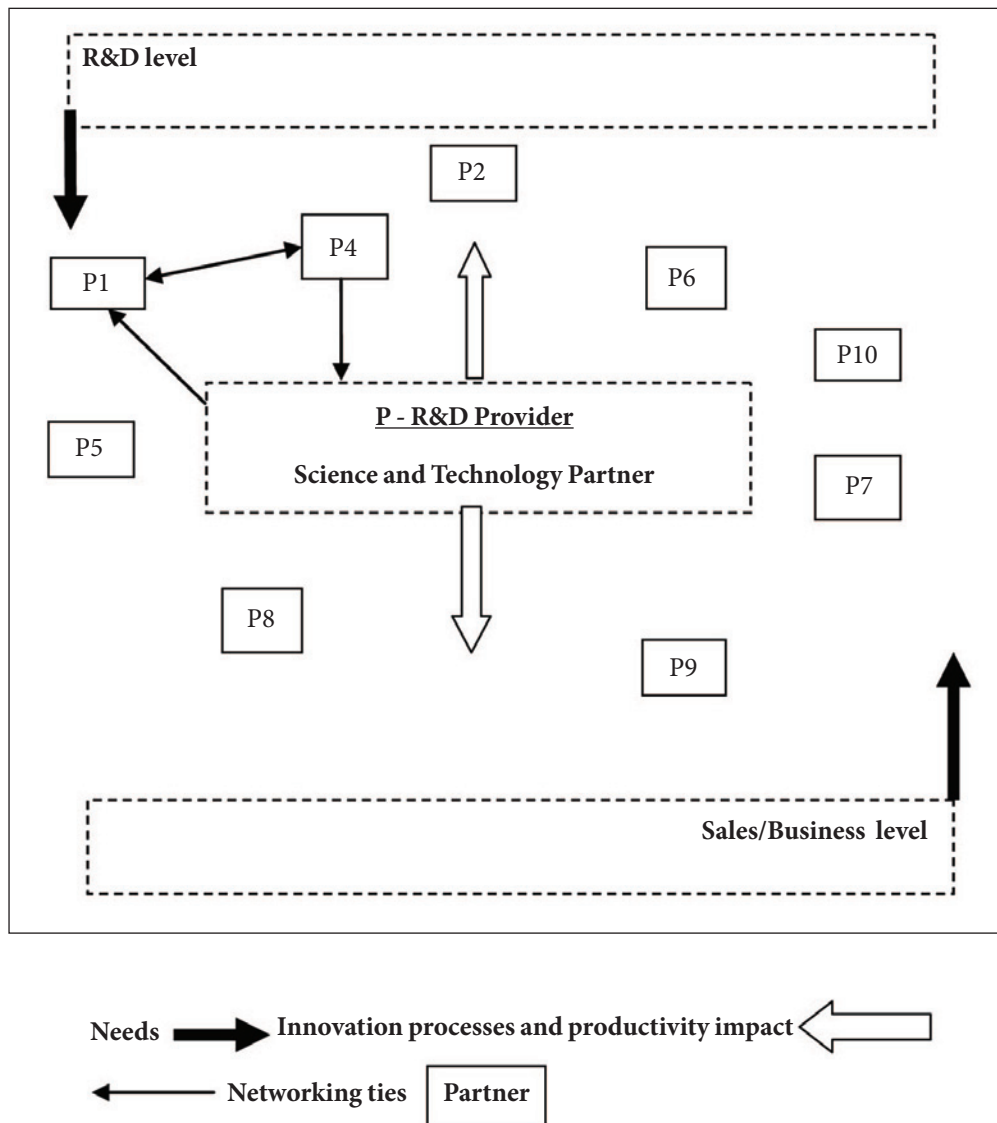


Fig. 1. Networking model and innovative performances

partners tend to be most important where the degree of competitiveness is complex and involve more technologies, capabilities and difficulties on the decision-making process. They are very important to promote and finance R&D contracts and R&D inter-firms projects in developing new innovation output in technology transfer perspective.

In addition, there are also some other external groups, which are not stakeholders of science parks but are linked to a science park or its firms. Such groups include, for example, accountants, auditors, lawyers, merchant and investment banks, business consultants and other service providers, which are located in and outside the parks or whose clients are mainly located in the parks.

To summarise, the science centre as Science and Technology Parks could become central actors in networking system for innovation, they could increase the number of linkages, could increase the diversity of ties and partners. Consequently, the different kinds of collaboration and actors involved in inter-organizational system could increase knowledge, critical mass, capabilities and innovation output.

The R&D Net Mod. is comprised of partners in both horizontal and vertical collaboration (from need of R&D at needs of Business Sales level) and it is comprised of a set of companies of short size whose main motivation for participating in a network is that of enhancing their knowledge by joint research and development ventures. With the main motivation for the individual partner being personal knowledge creation or enhancement, the synergic effects of the collaboration strategy are of great importance for transfer benefit on the internal productivity. Success often lies in the ability to set up and execute contractual research in complex areas without losing control, overview and manageability of the task at hand.

7. Conclusion and suggestions for future research

I believe these results have both practical/managerial and policy-makers implications. Entrepreneurs and managers of SMEs should be aware of the importance of R&D networking focused on specific agreements as driver of firms' competitiveness.

Empirical evidence confirms the positive role of R&D collaboration on the start of innovation processes in SMEs also in peripheral district. Nevertheless, empirical survey showed that R&D networking has not an impact on firms' productivity as (sales on innovation products). This research confirms that SMEs often find it difficult to establish and benefit from R&D inter-firms linkages; Networking process by itself cannot play a role in stimulating productivity but has a significant impact on the start of innovation processes. Difficulties regarding decision-making processes, innovation capabilities shortage, disproportionate focus on productive process and operations, risk sharing

and external factors, difficulties in finding of a hub/provider Science partner affect R&D networking impact.

The first managerial and practical implication regards the R&D networking model configuration. Moving from these moderate effects we propose a new model of R&D networking to revitalize firms' competitiveness. This model is based on the role of agreements provider partner as driver of innovation process and productivity.

The model has an impact on policy makers' decisions to revitalize, promote and finance R&D networking systems in peripheral districts. This is a relevant driver on the regional competitiveness.

Actually, the local productivity system considered in this analysis is characterized by a low degree of external collaboration and innovation capabilities. Final recommended line of research involves new business model configurations of SMEs. According to the business model literature, external changes (infrastructural, institutional, competitive, technological, operational) create the need to configure new strategic and organizational assets and core capabilities to create and maintain the firms' competitiveness. The new SMEs business model design and configuration as a strategic fit tool related to the R&D networking model proposed will be the target of further research and implication for entrepreneurs and managers.

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