Implementation of regional innovation networks: a case study of the biotech industry in Campania[1]

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Abstract

***Purpose of the paper**: The paper aims to investigate whether Distretto ad Alta Tecnologia Campania Bioscience - CB, an emergent regional innovation network promoted by the Campania Regional Authority, can become sustainable, i.e. whether it can achieve the expected results and last in the future.*

***Methodology**: The work is based on a qualitative method - a single case study - and investigates the sustainability of CB in reference to three theoretical aspects: a) the structure of innovation networks and the linkages established within them; b) the external context; c) the advantages and disadvantages of being part of such networks.*

***Findings**: The above theoretical aspects have been properly considered when implementing CB. Therefore, up to now, CB is a candidate for a sustainable regional innovation network.*

***Research limitations**: CB is still in an embryonic phase. This exploratory study leads to results that need to be confirmed - or that might be denied - by future, longitudinal studies.*

***Implications**: Policy makers aiming to implement new regional innovation networks could recall the best practices adopted by the Campania Regional Authority when implementing CB.*

***Originality/value of the paper**: To our knowledge it is rare to find articles trying to test sustainability of regional innovation networks in reference to Italy. This work therefore represents one of the first attempts to do so.*

Key words: innovation network; triple helix model; university-government-industry; economic development; entrepreneurial university

1. Introduction

Nowadays policy makers are increasingly interested in defining and implementing regional innovation networks that are inspired by the *triple helix model* - involving universities-governments-industries (Etzkowitz *et al.*, 2000) - and that aim to:

- exploit the innovations resulting from R&D carried out in universities and research centres through the commercialization of new technologies, new products or new processes;

[1] Although the paper is the result of the joint contribution of the authors, Mario Sorrentino wrote sections 1 and 3 while Diego Matricano wrote sections 2, 4, 5 and 6.

- support small and medium enterprises (SMEs), which usually do not carry out R&D activities, by offering innovations to be exploited;
- achieve economic development and growth in specific contexts.

Even if the implementation of regional innovation networks is positively evaluated since it is useful to achieve the development of a context (the main goal of governments) by matching the demand (from industries) and supply (from universities) of results of R&D activities, some scholars have investigated the causes of their possible failure (Orsenigo, 2001) or questioned their sustainability (Casper, 2007; Gilding, 2008; Zanni and Pucci, 2012). According to the above, this paper seeks to investigate whether the emergent regional innovation network *Distretto ad Alta Tecnologia Campania Bioscience - CB* promoted by the Campania Regional Authority in Southern Italy and related to the biotech industry can become sustainable, i.e. if it can achieve the expected results and last in the future.

The present work is structured as follows. In the following section, we start by reviewing the literature on the concept of the innovation network. At first, we focus on the transition from the closed to the open innovation model; then we examine the link between innovation network and entrepreneurship in depth. We seek to explain how innovation networks affect entrepreneurship, or, in other words, how innovation networks can be a driver, or a lever, capable of fostering and supporting entrepreneurial phenomena.

In section three, we underline the importance of innovation networks in knowledge-intensive industries. Our attention is chiefly paid to the biotech industry that, by definition, exploits the results of inter-organization R&D activities.

After defining the boundaries of the present research, in section four we underline the emerging interest in regional innovation networks based on the *triple helix model* and concentrate on three aspects that need to be considered when implementing it: a) the structure that innovation networks can assume and the linkages established within them; b) the context in which an innovation network can be implemented; c) advantages and disadvantages that can derive from being part of such a network.

The theoretical aspects treated above are instrumental to develop the single case study of CB, an innovation network whose main goal is to create a system supporting innovation, research and competitiveness in the biotech industry by establishing and developing strong collaborations between universities and industries. In section five we collect and analyze data and then we discuss the results.

The last section, number six, underlines the limitations of the study and suggests directions for future research.

2. Innovation networks and entrepreneurship

Acquiring external scientific and technological knowledge is crucial for the success of entrepreneurial ventures (Pittaway *et al.*, 2004). For

this reason, firms are switching from a closed innovation model, according to which innovation is secretly developed within the firm itself, to an open innovation model, according to which innovation results from an exchange of knowledge and competences with external subjects who are part of their network (Chesbrough, 2003; Chesbrough and Crowther, 2006; Laursen and Salter, 2006; Dahlander and Gann, 2010; Huizingh, 2011; West and Bogers, 2014). The networks created in order to achieve the above goal are appropriately termed innovation networks.

The origins of innovation networks can be dated back to the 1990s (Freeman, 1991; Lundgren, 1995; Osborn and Hagedoorn, 1997) and there seems to be a general consensus on their potential relevance to entrepreneurship (Gulati *et al.*, 2000; Adler and Kwon, 2002; Greve and Salaff, 2003). However it is still not clear how to evaluate the positive impact they generate (Hagedoorn *et al.*, 2000). According to the *Strategic Management* perspective, innovation networks affect achieved performances. In fact, the firms' capabilities in establishing, managing and sharing material and immaterial resources in an efficient way, the developed competences and the acquired knowledge can impact firms' performance. By contrast, according to the *Industrial Organization* perspective, innovation networks are relevant since they can influence the structure of industries, achievable efficiency and social wellness. In this case, success does not affect entrepreneurial ventures right away but rather passes through the configuration of the industry in which firms are positioned. From the perspective of *Transaction Cost Economics*, innovation networks are relevant since they can modify the market's or the industry's forces, as opposed to internal forces of ventures: hence a positive impact derives in defining the efficient boundary of firms. Eventually, according to *Strategic Entrepreneurship* perspective, innovation networks can facilitate both the discovery and exploitation of new entrepreneurial opportunities.

Despite the different theoretical perspectives that can be embraced and the possible measures of entrepreneurial firms' success, it is worth trying to identify the main characteristics of innovation networks. According to Rycroft and Kash (2004, pg. 187), for example, "*networks are those linked organizations that create, acquire, and integrate the diverse knowledge and skills required to create and bring to the market complex technologies. In other words, innovation networks are organized around constant learning*". In the above case, the most important aspect that scholars try to underline is the constant learning by entrepreneurial ventures. Very recent contributions, instead, have highlighted other aspects of the innovation network. Arranz and de Arroyabe (2012, pg. 488) maintain that "*the innovation network is a socio-technical system formed by three interdependent subsystems: process, structure and governance*"; they therefore highlight three aspects (process, structures and governance) that characterize each innovation network. Yet according to Corsaro *et al.* (2012, pg. 54), "*the innovation network is the configuration of strategic entrepreneurial nets aimed at improving the effectiveness of innovation performance*". In this last case, the most important aspect of an innovation network is its final goal.

By mixing the definitions above, it seems possible to sustain that an innovation network is a group of subjects involved in technology transfer

processes that is useful to share resources (mainly intangible ones, like knowledge or skills) in order to support and foster innovative processes (Powell *et al.*, 1996).

Such innovative processes are crucial for small and newly established entrepreneurial firms and for incumbent ones. The former can suffer from the liability of smallness and the liability of newness (Hannan and Freeman, 1984; Stinchcombe, 1965). The liability of smallness is due to the fact that small firms do not have many resources to invest; therefore it is difficult for them to compete with incumbents. The liability of newness results from the fact that new ventures have no reputation or legitimacy on the market. Thus, once again, they cannot compete with incumbents (Stinchcombe, 2000; Stuart, 2000). To overcome both of these liabilities, small and newly established entrepreneurial firms can decide to engage in different kinds of relationships or networks (Partanen *et al.*, 2011).

The second category of entrepreneurial firms, the incumbents, can be driven toward innovation networks in order to maintain their preeminent role in their industrial sector. R&D activities conducted by incumbent firms can suffer the risks linked to *lock-in or lock-out* theories. According to the lock-in theory, which is rooted in the entrepreneurial literature focused on the "*behavioral lock-in*" (Katz and Shapiro, 1985; Cowan, 1990; Barnes *et al.*, 2004), incumbent firms that have already carried out R&D for many years are specialized in some fields of research, so new research projects may be hard to design or start. They are locked into a well-defined research area and are thus excluded from some options (David, 2000). According to the lock-out theory, instead, incumbent firms cannot start new research projects because they might not possess the *absorptive capacity* - i.e. "*the ability of a firm to recognize the value of new external information, assimilate it and apply it to commercial ends*" (Cohen and Levinthal, 1990, p. 128) - required to do so (Spithoven *et al.*, 2011). In both cases, incumbents can start internal venturing processes (Burgelman, 1983; Block and MacMillan, 1993; Sorrentino and Williams, 1995) or, alternatively, they can enter and/or implement an innovation network.

In sum, both kinds of firms - new and small ones on the one hand, incumbents on the other - may be interested in innovation networks since, through them, they can discover new entrepreneurial opportunities (Elfring and Hulsink, 2003; Neergard, 2005; Pitt *et al.*, 2006; Matricano, 2011), obtain financial resources (Shane and Cable, 2002; Zhang *et al.*, 2008) or new technologies and knowledge (Lipparini and Sobrero, 1994; Pittaway *et al.*, 2004; Rickne, 2006). This confirms the importance that innovation networks can assume in fostering entrepreneurship.

3. Innovation networks in the biotech Industry

Innovation networks assume considerable importance in knowledge-intensive industries - such as ICT, nanotechnology, and biotechnology - where different and various resources and capabilities are required to start and conduct very complex R&D activities (Hagedoorn, 1993; 2002).

Over the last three decades, innovation networks developed in the biotech industry have been a focus of considerable interest (Arora and Gambardella, 1990; Powell *et al.*, 1996; Baum *et al.*, 2000; Audretsch and Feldman, 2003; Pisano, 2006). It is widely recognized that partnering among firms in the biotech industry is necessary (Baum *et al.*, 2000; Gambardella, 1995; Pisano, 2006; Powell *et al.*, 1996; Powell, 1998; Roijakkers *et al.*, 2005; Sorrentino and Garraffo, 2012) and very widespread (Hagedoorn, 1993).

The main reason for partnering and promoting innovation networks lies in the nature of biotech R&D. Because of the high complexity of this activity, it is difficult for a single firm to develop all the cognitive as well as tangible assets required to promote and develop innovation in the industry. Partnering with a multitude of actors thus reflects the necessity of cognitive work division in the industry (Gambardella, 1995; Orsenigo *et al.*, 2001; Rothaermel, 2001a, 2001b), and biotech companies can be motivated to become part of an innovation network because of the need for new and more focused scientific and technological competences (Powell *et al.*, 1996; Powell, 1998). At the same time, being part of an innovation network has proven to be a very important source of funding (prior to an IPO) for small biotech companies (Cunningham, 2002; Audretsch and Feldman, 2003; Pisano, 2006; Lazonick and Tulum, 2011). The necessity of additional substantial funds is particularly real in this industry, as firms conduct very risky research projects that can last for several years and whose final results may not even be exploitable on the market (Pisano, 2006).

The need to cooperate with operators providing complementary resources results in co-localization phenomena, i.e. the creation, in defined geographic areas, of inter-organizational innovation networks and clusters including universities, research centers, spin-off firms, large firms, hospitals, incubators, venture capitalists, and other suppliers of specialized resources and services. Geographical proximity stimulates the creation of inter-organizational relationships, thus making it easier for biotech firms to obtain the necessary complementary resources, in particular knowledge assets, thus stimulating and supporting innovative processes (Cooke *et al.*, 2006). This is particularly true in the healthcare biotech industry, where biotech companies and pharmaceutical firms spawn very intense networks aimed at developing new drugs. While biotech companies tend to focus on the early stages of the drug development process (i.e. discovery, pre-clinical development phase and phase 1 of clinical trials), big pharma concentrate on subsequent phases (late stage clinical development phases and regulatory activities) where huge complementary resources are needed. This highlights the clear division - but also a complementarity - of roles between biotech companies and big pharmaceutical firms (Gambardella, 1995).

However, geographical proximity and local interactions between partners within innovation networks are not enough to pursue innovation in a global industry like biotechnology. Indeed, firms in biotech innovation networks are increasingly promoting global networks and multinational relationships (Cooke, 2002, 2005; Bathelt *et al.*, 2004) in order to avoid the cognitive implosion of territorial clusters and remain innovative and competitive.

Being part of innovation networks in the biotech industry also has its risks. Typical risks connected to asymmetric information and moral hazard (Kogut, 1989; Hamel *et al.*, 1989; Khanna *et al.*, 1998) are operating within the biotech industry and may terminate the alliance before the established aim has been achieved. Another risk of biotech innovation networks concerns the learning races that may take place between biotech companies. This can happen in emerging biotech industries, such as the Italian one, where thousands of small biotech companies adopting similar business models compete to access strategic resources and sell the output of their R&D activity on knowledge markets (Baum *et al.*, 2000; Gans and Stern, 2003). In these learning races, small biotech firms try to achieve their learning goals first (Hamel *et al.*, 1989; Hamel, 1991) and compete for patentable compounds, thus seeking to internalize knowledge that has not been patented yet. As a result, network partners may lose incentive to invest in the network itself, leading individualistic behavior to prevail over cooperative efforts (Baum *et al.*, 2000). Thus, research partnerships between firms in the network show a "dark side" (Gulati, 1998; Gulati *et al.*, 2000) due to the riskiness and complexity of such interactions. In particular, these risks can cause the failure of innovation networks (Orsenigo, 2001) or negatively affect their sustainability (Casper, 2007; Gilding, 2008).

However, by comparing the motivations and the expected results with the negative risks connected to being part of an innovation network, biotech firms can consider this network as a very important tool to compete in the market despite some risks along the way.

4. Implementing a regional innovation network based on the triple-helix model: structure and linkages, context, advantages and disadvantages

As discussed above, innovation networks can be considered as drivers or levers capable of fostering and supporting entrepreneurship in knowledge-intensive industries. Starting from this, some scholars have started investigating the importance that innovation networks can have in reference to regional development. Regional authorities can promote innovation networks aimed at increasing innovativeness and fostering economic and social development within their boundaries (Cooke *et al.*, 1997; Keeble *et al.*, 1999; Lawson and Lorenz, 1999; Doloreux, 2002; Chiaroni and Chiesa, 2006). In these regional innovation networks, firms collaborate with other private firms operating in the same industry or with public institutions focusing on R&D - e.g. public research centers or universities - since they can provide the necessary resources and missing skills (Cooke and Morgan, 1998). In this context, based on the close-knit relationship between universities and industries and on the importance that governments assume in implementing and supporting such relationships, the *triple helix model* (Etzkowitz *et al.*, 2000) emerges. From a theoretical perspective, the convergence of aims on the part of universities, the industry and the government is easy to understand:

all concerned parties seek to foster the economic and social development of their own region. On the contrary, from a practical perspective, the implementation of specific actions is more complex. The government has to:

- steer R&D activities conducted by universities and research centers toward results that are exploitable by the industry;
- promote the achieved results in order to inform firms of the existence of exploitable results;
- manage exchanges between universities and the industry, and match demand and supply.

A very important role in the functioning of the triple helix model is ascribable to universities that, in the past decades, have been facing a profound change (Chiesa and Piccaluga, 2000; Etzkowitz *et al.*, 2000; Shane, 2004; Bramwell and Wolfe, 2008). Indeed, universities are now not only involved in research and educational activities, but they also try to achieve their third mission (Etzkowitz and Leydesdorff, 1999, 2000; Etzkowitz *et al.*, 2000; Etzkowitz, 2003). This mission consists in universities exploiting the results of R&D activities in order to support the economic development of the context in which they operate (Johnson, 2008). Firms have accepted this change and have thus started to leverage on the results of the R&D activities carried out by universities. Critical market conditions (high salaries, high entry barriers, and instability in market competition) are driving firms to reduce their R&D investments and seek innovations from the outside; universities seem to be able to supply them. Nevertheless, matching the demand (from industry) and supply (from universities) of R&D results is not a straightforward task. This is why governments (both at a national and regional level) play a crucial role in achieving this task.

Given their particular characteristics, it is far from easy to study regional innovation networks and generalize the results they can achieve. For this reason, three main paths of research have been addressed. They concern:

- the structure of innovation networks and the linkages established within them;
- the external context;
- the advantages and disadvantages of being part of innovation networks.

These three research paths are reviewed and debated in the following sub-sections in order to try to point out their main characteristics.

4.1 Structure and linkages

Even if we can easily realize who are the involved subjects (i.e. government-industry-university), it is not possible to generalize the structure of innovation networks (Pittaway *et al.*, 2004; Salavisa *et al.*, 2012). As noted by Ricciardi (2006), each innovation network assumes a specific structure in reference to the hoped-for results. Thus, no generalization is allowed. However, it seems possible to find out some key aspects that can give information about the structure of innovation networks. According to Ricciardi (2006), there are two key aspects, namely the relevance of the actors and the evolving structure over time.

As for the relevance of the actors, it is important to ascertain if networks are spontaneous, policy driven or hybrid (Chiaroni and Chiesa, 2006).

They are spontaneous when favorable conditions take place without the commitment of public actors. On the contrary, they are policy-driven when there is a strong commitment of policy makers. In particular, policy makers can start industry restructuring policies or industry development policies. If needed, they are hybrid when governments intervene in order to support spontaneous networks that still exist but are underdeveloped or declining.

As for the network structure, it is important to note that innovation networks are supposed to change over time. The possibility that new members can join it or that old members can leave it necessarily means that the structure of the innovation network can be modified and, as a consequence, no generalization is allowed. However, in reference to the structure, some scholars (Salavisa *et al.*, 2012) invite us to pay attention to:

- size: since firms enter or create an innovation network in order to obtain resources they do not have, the higher the number of actors involved, the greater the chance of obtaining additional resources (Burt, 2000). This means that firms try to involve other actors by modifying the structure of their innovation network;
- type: when the involved actors carry out similar activities, there can be a problem of redundancy (Burt, 1992); on the contrary, when they carry out dissimilar activities, new resources are easily obtained (Baum *et al.*, 2000). There is a continuous search for actors to remain in contact; hence the structure can be modified;
- positioning: the relational position makes the exchange of resources much easier, which is a very important aspect to consider in innovation networks (Powell *et al.*, 1996). Actors in innovation networks try to get closer to the center, also termed as peak (Scott, 1991; Greve, 1995; Johannisson, 1998), therefore possible changes can take place in reference to the structure;
- links: kind, content and frequency of links determine the possible structure of innovation networks. The decision to leverage on strong or weak (Granovetter, 1973; 1985), formal or informal (Birley, 1985), additional or redundant (Burt, 1992; 2000), or on direct or indirect ties (Podolny and Baron, 1997; Ahuja, 2000) affects the structure of the innovation network and makes generalization impossible.

According to the above-mentioned contributions (Ricciardi, 2006; Salavisa *et al.*, 2012), neither the structure nor the linkages of a regional innovation network can be generalized since they can always change according to established objectives.

4.2 The external context

The external context can determine the success or failure of regional innovation networks (Bramwell and Wolfe, 2008). Some contexts, in the sense of geographical contexts, can be considered *knowledge innovation zones* where it is possible to establish very strong connections and stimulate new entrepreneurial activities. In particular, this can be due to the spillover effect and to *technological brokers*.

The spillover effect, which can be defined as a positive externality that a subject not involved in R&D activities can obtain from the results of R&D activities carried out by others, is much stronger if the source and recipient of knowledge are geographically close. This is particularly true when the transfer processes concern tacit knowledge that is not formalized. Of course, if the transfer process concerns codified knowledge, for example through patent citations, geographical proximity is not so relevant.

As mentioned above, *technological brokers* play an important role in innovation networks (Amico Roxas *et al.*, 2011) since they can affect the success or failure of innovation networks. Effectiveness in exchanges of knowledge inside the network depends on the competences and skills that dedicated offices possess - these offices are properly named *technology transfer offices or industrial liaison offices* (Lockett and Wright, 2005; O'Shea *et al.*, 2005; Siegel *et al.*, 2007; Gómez Gras *et al.*, 2008). They deal with the commercialization of research results and, in particular, they deal with the facilitation of internal and external information flows and the definition of incentives (Phan and Siegel, 2006).

In contexts where the *spillover effect* is greater and where *technological brokers* are more efficient, regional innovation networks are more likely to achieve the established results.

4.3. Advantages and disadvantages

The last aspect to consider when studying regional innovation networks concerns the advantages and disadvantages of being part of them (Ricciardi, 2006). The main advantages entail knowledge transfer, distinctive competences, financial resources, and exploitation of innovations. By contrast, the main disadvantages concern opportunistic behavior, asymmetric contributions and different aims.

The first advantage is related to the easiness of tacit knowledge transfer. Being part of the same innovation network suggests that all the involved subjects have already developed *absorptive capacity* (Cohen and Levinthal, 1990), even if, as already stated in reference to the lock-out theory, this might not happen. Generally speaking, since all the firms and universities involved operate in the same industry and should therefore have accumulated the same specific knowledge, the exchanges that are implemented in regional innovation networks are expected to be straightforward and, above all, to reinforce the *absorptive capacity* of each of the components. The second advantage is linked to distinctive competences that can be developed (Boardman, 2008). Firms can develop integrative competences (in order to mix internal and external knowledge), coordinative capabilities (capable of synchronizing new acquired knowledge) and generative capabilities (through which new knowledge is created). The third is linked to funding and economies of scale and of learning, which arise from sharing R&D costs. Finally, the last advantage consists in the straightforward exploitation of technological innovations.

However, being part of regional innovation networks can also cause some drawbacks. The first may stem from opportunistic behaviors (Williamson, 1975) that others can put into practice, both before and after

drafting the contract ruling the partnership. This kind of disadvantage was examined in agency theory (Jensen and Meckling, 1976). The second disadvantage can arise when subjects involved in the network do not share the resources arranged or when they pursue different aims. In both cases, the subjects are forced to proceed with the network activity or they could be interested in leaving the network. Both the possible advantages and disadvantages are shown in table 1.

Tab. 1: Implications of being part of innovation networks

Advantages	Disadvantages
1) Knowledge transfer	1) Opportunistic behaviors
2) Distinctive competences	2) Asymmetric contributions
3) Financial resources	3) Different aims
4) Exploitation of innovations	

Source: Adaptation from Ricciardi (2006)

5. The case study: Distretto ad Alta Tecnologia Campania Bioscience

5.1 Research design

As for the research design, we decided to carry out an explorative qualitative analysis using a single case study method (Eisenhardt, 1989; Yin, 1994). Although we know that in managerial disciplines there is still a predominance of quantitative methods (Lee *et al.*, 2007) - based on empirical data and statistical elaborations - we decide to conduct a qualitative analysis - based on a single case study - since it seems to better fit our research aim. As anticipated, in fact, we try to investigate whether *CB* can become sustainable and whether it can provide some *best practices* that other regional authorities implementing new innovation networks in the biotech industry could replicate. In other words, we start from a single and very detailed case study and we try to propose a general theory or model (Dyer and Wilkins, 1991; Eisenhardt and Graebner, 2007).

5.2 Data collection, analysis and results

In order to investigate whether CB can become a sustainable regional innovation network, we consider the theoretical items that emerged in previous sections in reference to the three main paths of research:

- the relevance of actors and the structure of the regional innovation network (size, type of activities, positioning, links);
- the external context;
- the advantages and disadvantages of belonging to innovation networks.

Data have been collected from different sources. Some of them have been downloaded from official websites (www.regione.campania.it, www.ponrec.it and www.bioteknet.it), some have been collected from

newspapers and some more detailed data derive from interviews with key informants and promoters of CB.

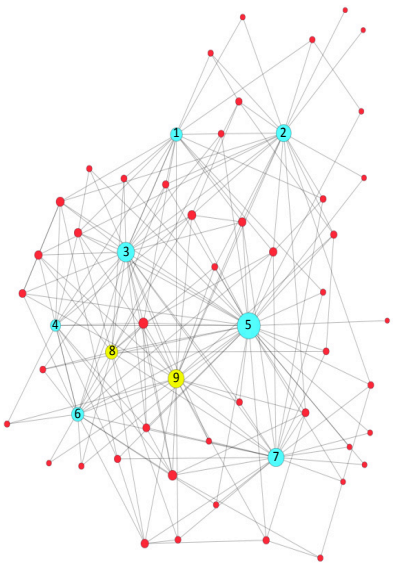
The first research path deals with the relevance of actors and the structure of the regional innovation network (see section 4.1). As for the relevance of involved actors, we need to start from the creation of CB. The project regarding its implementation can be dated back to March 22nd, 2011 when the feasibility study was presented. In April 2012, the Italian Ministry of University and Research (MIUR) approved the above feasibility study, and in August 2012 the agreement between the MIUR and the Campania Regional Authority, properly termed "*Accordo di Programma Quadro*", was signed. In February 2013, a limited liability consortium was established. In reference to the classification proposed by Chiaroni and Chiesa (2006), CB is a hybrid network and it aims to foster and develop the biotech industry in Campania. As emerged from an interview with a key actor, "*CB has been created in order to formalize previously established relationships among partners*". This means that the Campania Regional Authority has played - and actually still plays - a crucial role in the implementation of this *triple-helix* model.

As for the structure, we need to investigate its size, type of activities, positioning and links. Fifty-five subjects are involved in CB are up to now. In particular, there are seven research institutes (both universities and research centers), two technology-transfer offices and forty-six firms (ten big, eleven medium and twenty-five small firms). By comparing CB with both international and national networks in the biotech industry, we can infer that it is small-sized (probably due to its recent creation). One of the interviewed key actors emphasized that the "*small size of CB has facilitated its implementation and can facilitate its management*". The activities carried out by the fifty-five partners - the second aspect to be considered - are totally different. Research institutes and universities focus on R&D activities, technology-transfer offices on knowledge exchanges and firms on final exploitation. Thus, the problem of redundancy seems to be reduced to minimum. As for the positioning, even if the Campania Regional Authority has driven the creation of CB, there is no peak (Scott, 1991; Greve, 1995; Johannisson, 1998). As emerged from one interview, "*this means that each subject can look for the most suitable partner to collaborate with, according to specific needs or aims*". Later, as for the links inside CB, we rebuilt the relationships between involved partners but we could not acquire information on the kind of established ties (whether they were strong or weak, formal or informal, additional or redundant, direct or indirect). After collecting these data, we performed a network analysis using Gephi - an open-source network analysis and visualization software package - to elaborate the data. Results are shown in Fig. 1.

The results deriving from the network analysis show that both universities/research centers and technology transfer offices cover a relevant role in CB since involved firms have not implemented relevant relationships among themselves yet. This is confirmed by the density value - calculated through Gephi - that is equal to 0,125 (this value is given by the ratio between the amount of established, effective relationships and the amount of all possible, potential relationships and so it can vary between 0, where involved partners do not collaborate with each other, and 1 where all the

involved partners collaborate). This low value means that many of their involved partners do not collaborate with each other. Despite this, key informants argue that the relationships that are already established inside CB are a clear signal of trust between involved partners and this sounds like a promising basis of CB.

Fig. 1: The shape of the CB network



Notes

The nodes numbered from 1 to 7 indicate research institutes involved in CB:

1) University of Sannio
2) University of Salerno
3) National Council of Research - CNR
4) Biogem
5) University of Naples Federico II
6) Ceinge
7) Second University of Naples

The nodes numbered 8 and 9 indicate technology transfer offices involved in CB:

1) Technapoli (TTO)
2) Bioteknet (TTO)

The other nodes (not numbered) indicate all the 46 firms involved in CB.

Source: Personal elaboration

The second research path recalled before deals with the external context (see section 4.2). In order to analyze the regional context *CB* is in, it is appropriate to start from the data published in a report by Ernst & Young (2014) entitled "*Rapporto sulle Biotecnologie in Italia - BioinItaly Report 2014*" and referred to 2013. The report provides an overview of the biotech industry in Italy, with the distribution of biotech ventures on a regional basis (tab. 2).

Tab. 2: Distribution of Italian biotech ventures among regions

Italian biotech ventures per region		
Region	Number	Percentage
Lombardia	127	30.1%
Piemonte	48	11.4%
Toscana	39	9.2%
Emilia Romagna	38	9.0%
Lazio	36	8.5%
Veneto	27	6.4%
Friuli Venezia Giulia	23	5.5%
Sardegna	20	4.7%
Campania	12	2.8%
Puglia	12	2.8%
Liguria	8	1.9%
Marche	7	1.7%
Sicilia	7	1.7%
Molise	4	0.9%
Trentino Alto Adige	4	0.9%
Abruzzo	3	0.7%
Calabria	3	0.7%
Umbria	2	0.5%
Basilicata	1	0.2%
Valle d'Aosta	1	0.2%
Total	422	100.0%

Source: "Rapporto sulle Biotecnologie in Italia - BioinItaly Report 2014", Ernst & Young

Campania is in ninth position on the list and, according to specialists (Ernst & Young, 2014), it seems to be a promising context for the future development of the biotech industry. In particular, the region can aspire to become a *knowledge innovation zone* where new processes of *inventing around* can take place.

The third research path deals with the advantages and disadvantages of belonging to innovation networks. In order to rebuild this last research path, we need to start from the strategic objectives that the governance of the network has set up for its future functioning. These objectives (summarized in table 3) follow three main lines of intervention.

Tab. 3: Lines of intervention established by Campania Bioscience

Lines of intervention
Line 1 - Industrial research and experimental development - concerns three main fields of research:
A) Development and production of new biotech products
B) Diagnostics, bio-sensorial systems and innovative technology for the biomedical industry
C) Development and experimentation of new therapies
Line 2 - Higher Education - deals with education of researchers and technicians and concerns:
A) Industrial research projects and pre-competitive development
B) Managerial and technical skills
Line 3 - Promotion, internationalization, diffusion and technology transfer - includes six actions:
Action 1: Diffusion, dissemination and valorization of research results
Action 2: Patent protection
Action 3: Supporting the start-up process
Action 4: Internationalization of district and networking activities to obtain external funds
Action 5: Communication inside and outside the district
Action 6: Cooperation in international R&D

Source: Report edited by Distretto ad Alta Tecnologia Campania Bioscience, 2013

The first line of intervention refers to industrial research and experimental development and includes three main expected innovation outputs. The second deals with higher education. According to this line of intervention, network actors will share educational activities aiming at specific goals. The third and last line emphasizes the promotion and internationalization of the network along with the need to stimulate both the dissemination of scientific results and technology transfer processes.

By keeping these three lines of intervention in mind, we can now compare the advantages and disadvantage of being part of innovation networks (as emerged during the theoretical analysis presented in section 4.3). The first advantage is linked to technology transfer (which is dealt with in the second and in the third lines of intervention, see table 3). One of the interviewed key actors emphasized this by arguing: "*CB is a hybrid network where knowledge exchanges are carefully planned and coordinated in order to reach predetermined aims*". The second advantage deals with distinctive competences shared by partners (mainly included in the third line of intervention). As previously mentioned, the fifty-five subjects involved in *CB* are of different natures (they are private or public subjects; they are companies, universities, research centers or technology transfer offices) so they can create the right expectations of sharing non-redundant competences. The third advantage refers to financial resources (the third line of intervention). According to data provided by *CB*, in

February 2013 the network started its activity with a share capital of nearly 1.7 million euro. Nowadays, thanks to the involvement of public and private partners, the total of resources held by *CB* amounts to nearly 50 million euro. During the interview with one of the CB promoters it emerged that "*all the partners involved in the network share the mutual-aid aim of the network so that its net profits are reinvested in R&D activities*". The fourth and last advantage refers to the exploitation of innovation (included in the first and third lines of intervention). This advantage has not been realized yet.

Of course, there are some disadvantages. According to the theoretical analysis (section 4.3), the first two disadvantages concern opportunistic behavior and asymmetric contributions (which is dealt with in the first and in the second lines of intervention, see table 3). These disadvantages - which "*can never be eliminated but can be reduced*" according to a key informant - do not seem to constitute a real drawback since the partners involved in *CB* already have some collaborations in place. Reciprocal trust is at the basis of established relationships and this seems to be a promising premise for present and future partnerships within *CB*. The last disadvantage deals with different aims. Until now, this has not seemed to constitute a real threat. An interview with a key actor has revealed that "*all partners are very interested in the internationalization process and this seems to prevail over individual and specific goals*". This is in line with the idea that firms in biotech innovation networks need to promote global networks and multinational relationships (Cooke, 2002; 2005; Bathelt *et al.*, 2004) in order to avoid the cognitive implosion of local networks.

The present analysis - by investigating the relevance of actors and the structure of the regional innovation network, the external context and the advantages and disadvantages of being part of innovation networks - drives to assume that *CB* is a good candidate as a sustainable regional innovation network. This result is due to the willingness both to exploit the positive aspects on which regional innovation networks can leverage and to reduce the risks that may arise.

However, before concluding, we need to state that investigation about *CB*'s sustainability cannot be taken for granted. *CB* is still in an embryonic phase. This means that positive signals - which let us foresee *CB* as a sustainable regional innovation network - can be due to a careful implementation, but at the same time this means that negative signals have still not been revealed because of its recent creation. Of course, even if we cannot ignore such a recent creation, we need to highlight that *CB* is a hybrid network aiming to formalize previously established relationships and manage them in order to achieve better results. Generally speaking, the establishment of *CB* has been intended and carefully planned, so any risk has been reduced to a minimum. Therefore, if *CB* is going to proceed along this way - by ruling the network according to regional policies, monitoring its structure, referring to internal strengths and to opportunities offered by the external context, leveraging on some positive advantages and trying to avoid emerging disadvantages - it could really aspire to become sustainable. Moreover, *CB* could legitimately aspire to be an example of *best practices* when implementing a new regional innovation network in the biotech industry.

6. Limitations of the study and suggestions for future research

In order to investigate whether *CB* can be a sustainable regional innovation network, we have analyzed three main aspects related to its structure and the linkages, context and possible advantages/disadvantages of being part of it. As emerged previously, *CB* is a candidate for a sustainable regional innovation network.

Despite the achieved results, the present work presents some limitations that need to be underlined. The first one refers to the selected case. *CB* is an emergent regional innovation network and, as such, many of its key aspects have already been defined but not totally implemented. This lets us test its sustainability but, at the same time, it does not give us any certainty about its future development. This is the reason why entrepreneurial scholars focus their attention on established networks so studies referred to emergent networks are rare to find (Zanni and Pucci, 2012).

Two more limitations deal with research method. In particular, one limitation is related to the use of the case study method. Despite its use in managerial studies, it is still criticized and its validity is still questioned. Another limitation, instead, concerns the use of a single case study whose results - in comparison with the ones deriving from multiple case studies - are even more criticized and questioned.

The above limitations represent possible starting points for future research. In particular, the fact that *CB* is an emergent regional innovation network requires us to repeat this study in the future after completing its implementation. Alternatively, an international comparison could help define whether *CB* has been implemented according to best practices that other policy makers could adopt when establishing new regional innovation networks in the biotech industry.

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