BASIC vs APPLIED RESEARCH:
NEW LINK, NETWORK and PROJECT GOVERNANCE
Lessons from four biotech research-based organizations

Abstract

Based on a qualitative research approach, this paper explores how four highly successful biotechnology organizations source their most critical input-scientific knowledge and integrate it inside. We selected matched pairs of organizations that operated under similar conditions and regulatory regimes (Southern Italy) but differed considerably with regard to ownership (public and private). We find that scientists enter into large numbers of collaborative research efforts (frequently informal) with scientists at other organizations, especially universities. Formal market contracts are also used to govern these exchanges of scientific knowledge. Inside, the main job in integrating new information and knowledge, is carried up by few critical connectors. Our findings suggest that the *reputation* is the real, effective intangible resource at the base of these relational activities for value creation in all the cases.
We selected the Dynamic Capabilities (DCs) model proposed by Teece, Pisano, Shuen, 1997 and by Teece, 2007, as the core theoretical guideline for the present study.
Following DCs, we consider the places where basic and applied research meet as the "critical-zone" for value creation in biotech organizations.
Another analytical tool is the network approach to find and fix the critical organizational dimensions under network domains.
Our findings enable a future research pattern based on a tested informal relation codification. It will be possible to implement a quantitative research on a higher number of observations.

This thesis is divided into the following sections. **In chapter I,** the research topic is presented as an empirical, real-changing movement, drawing on the case of USA and its national biotech-innovation system, in other words the change in the relational dynamic between basic and applied research. As such, the formulation of the general research question emerges out of a simple consideration of the corresponding problem for the Italian context, specifically southern Italy. **Chapter II** deals with the method and research questions and describes the modes of organizing the analysis. As the method is qualitative and focused on case studies, this section also presents the theoretical issues we referred to for data analysis and evidence discussion. We refer, here, to the dynamic capabilities theoretical approach presented mainly in two fundamental articles by Teece et al. on 1997 and by Teece on 2007.

Additional theoretical subjects are outlined in **chapter III**. These arguments complement the research context by providing a bird's-eye view at organization analysis and social network contributions. Our attempt is to find some insights into where strategy scholars might look for hidden resource for value. Here the fundamental contributions are those of Jones, Hesterly, Borgatti (1997), of Cross, Borgatti, Parker (2002), Cross, Parker (2004), and of Powell and Grodal (2006). The section, finally, presents the empirical analysis, starting from firms' description, data collection and data analysis. In this section we focus more on explaining the construction of the SNA questions and the measures of DCs.

In Chapter IV the findings are grouped in three key-issues: configuration of Biotech Firms' relational and integrative capabilities and value implications, evidence in terms of process-position-path and (organizational) convergence solutions, basic vs applied research networks: governance and incentive issues. In a final section, we collected the ending notes and the future research agenda.

Keywords: Innovation, Dynamic capabilities, Organization, Governance.

Contents

Abbreviations:

BF: Biotech Firm
DC: Dynamic Capability
EU: European Union
NSF: National Science Foundation
NIH: National Institute of Health
RBV: Resource-based View
R&ICs: Relational and Integrative Capabilities
SNA: Social Network Analysis

Società Chimica Italiana (SCI)/Italian Chemistry Society
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"A year ago, in the January-February edition of "Chemistry and Industry", together with some encouraging notes on the progress of the pharmaceutical sector in Italy, and a focus on the biotechnology sector, was presented a negative outlook on the future of Italian pharmaceutical research in relation to drugs based on molecules of low molecular weight. Prof. Most (Past-President of the Division of Medicinal Chemistry Italian Chemical Society) brings out clearly the criticism of the decisions of heads of major multinational companies (Pfizer, GlaxoSmithKline, Merck, in particular) concerning the survival of their research centers in Italy. Unfortunately, we can only say that what he said in the article, in fact, turned out to be a true prophecy. A few examples among many: the Center of IRBM in Pomezia closed its doors, reopening only in recent days, with different owners and, above all, with a small staff of about 15% of what it was at the end of 2008, and the result was the loss of 200 or more jobs abroad and emigration of a large proportion of highly qualified researchers. The Research Center of Cell Therapeutics in Bresso was dismantled and in this case jobs were lost and a large number of researchers were forced to emigrate abroad. Finally, a month ago, GSK announced the closure within a few months of its research center in Verona, the flagship of Italian pharmaceutical research and recognized by WHO as a center of excellence for research in neuroscience. Today, the center of Verona, today consists of about 500 researchers in addition to a large number of operators in other establishments, yet again many of its qualified researchers have left for other countries, where, despite the crisis and closure of research centers, investment alternatives are created and continue to meet the changes brought about by restructuring and changes to strategic plans of large companies. A striking example in this regard is the decision of the British Government to reduce taxes on gains from patents in the UK. That decision, we are sure, sets the stage for various multinational companies deciding to make additional investments in the United Kingdom. The same GSK announced a few days ago that 1,000 new jobs would be created, about half of which in the biotechnology sector, compared to a reduction of about 400 positions in its research centers based in the north-east of London.

We believe that the above not only highlight the problems created for individual researchers, no doubt serious from a human point of view, but also the situation of pharmaceutical research in Italy has now reached a "tipping point" beyond which damage to the so-called *sistema paese* or "country system" is imminent and it will be very severe and prolonged. The pharmaceutical sector is a sector with high technology and high added value so that it can actually create wealth for a country. For this to happen, however, what is needed is investment capacity, capability and commitment to long-term planning. Typically, the return of investment in this sector is in the order of 10-15 years, and even then the measures taken have marginal and limited effect in the rescue of this strategic sector. In the 1960s and '70s, our country was at the peak of pharmaceutical research, today it is a strong rearguard position, but what was destroyed in 30 years needs to be rebuilt with a unique vision that looks to both the industrial and academic worlds.

The Division of Medicinal Chemistry of the Italian Chemical Society therefore believes that investors and institutions can and must find the appropriate forms to ensure the survival of those research centers of excellence that still exist in Italy. The immediate action must involve long-term plans whose aim is to reverse the trend of the past 30 years with a view to seeing our research flourish and to ensure that our youth are not only appreciated abroad, but they find the will and the means to invest in their future in Italy".

The Division of Medicinal Chemistry of the SCI, in its institutional role, has an interest in chemical and pharmaceutical development of culture and promotion of all those academics, industrialists, students, scholars, dealing with the chemistry of drugs. In this function, the Division intends to play an active role with public and private actors in order to identify those actions aimed at creating a mid-term to long-term sustainability of the Italian pharmaceutical research.

The President and the Division of
Medicinal Chemistry Board of Directors

Introduction

This recent statement by the President of the Italian Chemical Society denounces the critical situation of research in our country. Numerous research units belonging to many chemical companies have reduced investment, resulting in a significant impact on employment and subsequently driving skilled researchers abroad (brain drain).

At the same time, the Italian public research context has been affected by a profound transformation. The process of renewal and modernization embracing Public Administration, involving all its branches, is now impacting heavily on research actors such as Universities and CNR (Consiglio Nazionale delle Ricerche or National Research Council).

In Italy, the two areas of public and private research, which historically correspond to the distinction between basic and applied research, are in effect not linked today. The major impulse fuelled by biotechnological innovations has, among other things, reformulated the same modes of research management and introduced new forms of governance at the organizational level, principally the approach of basic research to the market.

This issue involves macro and micro level argumentations, which we place on a common logical path, as follows:

- The case of biotechnologies in Italy – and for EU economies – is a case of competitive re-positioning. Global competition moves toward research-based frontiers: product and process innovations and, in general, all those intangible, high-skilled human capital assets as sources of production of knowledge and value. The changing scenario drives competitive economies to focus more on these emerging value-creator industries.

- At the same time, at firm level the potential opportunities offered by these value-creator activities are mostly unknown, as one entrepreneur in our survey stated: "Our business opportunities in the biotechnology field are almost unknown, and we are unable to find them by ourselves. These opportunities may emerge from direct and indirect collaboration we frequently engage in with external actors. The most fruitful business activities have occasionally been created during meetings with our production partners, pooling together our knowledge. For these reasons I talk of the importance of the "lateral thinker" who can interact pro-actively with the persons he already knows and trusts". These words show and bear witness to the importance of finding a conducive environment in which the actors are able to talk each other.

- There is an additional condition for research-based organizations in southern Italy: local assisted governance, until the recently founded Competence Centers, had failed insofar as integration between Research and Industry is concerned. This failure, to be argued and supported with some evidence in chapter 1, may be considered in terms of inefficient coordination between the "locus" of research and industry.

The current scenario poses different problems of both a structural, organizational and technological nature. These dynamic variables contribute to create a “volatile environment” or, in other words, a context where the ability to adapt is critical.

To give an idea of the complexity of this phenomenon, we can refer directly to the introduction of Powell’s study on the Network of Innovators, published by Oxford University Press, in 2006:

“In February of 2001, two rival consortia published rough draft (roughly 90 per cent complete) sequences of the human genome in *Nature* and *Science*. The “public” Human Genome Project consisted of five key institutions and eleven collaborations, supported by the US National Institutes of Health, Department of Energy, and the Wellcome Trust in the United Kingdom. The rival “private” consortia, led by the biotech firm Celera, included both commercial firms and academic researchers from the University of California, Penn State, Case Western, Johns Hopkins, Cal Tech, Yale, Rockefeller, as well as scientists in Spain, Israel, and Australia. These projects have been acclaimed for their remarkable scientific achievement; they were also the product of considerable organizational innovation. ..The Human Genome Project (HGP) and the Celera team were pluralist, multiorganizational and multinational confederations. These two groups were intensely rivalrous, but collaborated intensively within their own groups (Lambright, 2002). HGP involved management by two government agencies and a private British foundation that coordinated activities in government labs, universities, and nonprofit institutions in the US and England. As the lead firm, Celera’s organization was more focused, but its research team included scientists and state-of-the-art equipment at private firms, public and private universities, and nonprofit institutes in four countries.

Both projects were organized as large-scale networks, and their rivalry spurred each side to engage in a high-stakes learning race. While the cost, scale, and distributed nature of these projects may have been unusual, the form of organization-collaboration across multiple organizational boundaries and institutional forms-is no longer rare. Indeed many analysts have noted that the model of network of innovators has become common place over the past two decades (Powell, 1990; Rosenbloom and Spencer, 1996; Roberts and Liu, 2001; Chesbrough, 2003).

Collaboration among ostensible rivals was once regarded as provisional or transitional step taken to enter new markets, spread risks, or to share early stage R&D costs (Mowery, 1988). Such forays were often followed by mergers as the transitory activities became incorporated inside the boundaries of the firm. Recent studies suggest, however, that various forms of interorganizational partnerships are now core components of corporate strategy. Even where these linkages endure for relatively lengthy periods of time, they do not entail vertical integration (Gomes-Casseres, 1996; Hagedoorn, 1996; Noteboom, 1999; Ahuja, 2000)….Many studies of interfirm networks draw data from a single point in time and thus do not examine how collaborations unfold over time. Even studies that do look at dynamics tend to do so from the perspective of a dyad. Initially, the choice by a young firm of whom to partner with is often driven by resource needs. As both firms and network mature, various dyadic choices increasingly reflect structural properties of the network. **Thus, the existing network structure shapes research behavior**. Consequently, networks both enable information to become knowledge and determine the nature of knowledge (Kogut, 2000). But we do not, as yet, have a parallel understanding of the management and governance of networks to accompany analysis of structure and topology. Concerns with how the parties in a relationship adapt to changing circumstances, or attend to the incentives to adjust the relationship to make improvements remain largely unexamined".

This paper seeks to address the challenges outlined above. We present its core contribution, with a brief illustration (see Fig. A) and description in the following section, starting from the methodological choice and, subsequently, through a presentation of the derived theoretical logic.

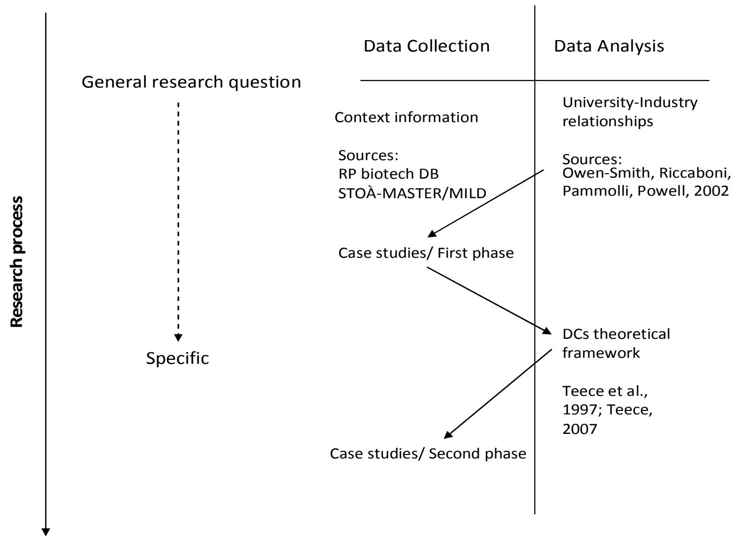
The research method applied is qualitative and based on case studies. The research process is inductive and, for this reason, there is a cycle of alternation between data collection and analysis. In other words, guided by an initial research question (how to address the supply of basic research in southern Italy), we collected a first set of data (two early case studies). At this point we began to analyze data and, guided by emerging theoretical directions/paths (until the formation of derived research logic), a second set of data was collected.

The emergence of derived research logic follows argumentation of the notion of collective invention (Allen, 1983) and the subsequent scientific debate on University-Industry relationships (Owen-Smith, Riccaboni, Pammolli, Powell, 2002). With regard to biotechnologies, important contributions compare the evolution and structure of the biotech sector in the United States and in Europe, and consider the implications for European competitiveness in the same sector (Sharp, Senker, 1999). More recently, other research works conducted on the same issue (Owen-Smith, et al., 2002; Owen-Smith, Powell, 2004) have shown how systematic variation in the composition of networks across nations, and within regions, influences the ability to integrate scientific, clinical and commercial expertise. Of particular importance for biomedical innovation are linkages between scientific research and commercial and clinical development. Owen-Smith et al (2002) identify two macro-level capabilities that influence these linkages: integrative and relational capabilities. These refer respectively to the ability of scientists to move back and forth between basic science and clinical development, and to the ability of organizations within an innovation system to collaborate with other, diverse organizations.

On a different research trajectory, the Dynamic Capabilities (DCs) theoretical view (Teece et al. 1997; Teece, 2007), in adhering to a firm-level research approach, focuses attention on environmental dynamism and on the specific responses the organization may give to it. At the same time, given its strategic vision, the framework underscores the importance of interpreting, in advance, the dominant industrial structure and market competition. Competitive advantage may arise only for the firm that recognizes and applies environmental priorities by using its dynamic capabilities. "Dynamic capabilities assist in achieving evolutionary fitness, in part by helping to shape environment. The element of dynamic capabilities that involve shaping (and not just adapting to) the environment is entrepreneurial in nature. Arguably, entrepreneurial fitness ought to have equal standing with evolutionary fitness (Teece, 2007. Pg. 1321)". Where the market changes, this ability to understand the context must be, in turn, dynamic.

For our analysis, we choose to observe firm-level capabilities (following the DCs methodological guideline) that, we assume, are represented by relational and integrative capabilities (R&ICs) to connect basic and applied research. The specific research question, therefore, looks at HOW the organization recognizes and applies R&ICs. Starting from the observation of success cases, we were able to identify specific solutions.

Figure A: The research process



Source: our elaboration

A fundamental feature of this research is evident in the methodological approach; it is qualitative and based on case studies and, consequently, the research process consists in the alternate repetition of collecting and analyzing data. It is a process that starts from the *open code phase*, based on a broad definition of the research target, and goes on to *select codes*, namely the research phase in which the theoretical framework and specific research questions are defined. The process may be stopped at a certain point and then resumed in a subsequent phase when research questions may be updated on an increasing number of firms, moving toward a new theoretical and more comprehensive framework.

To date, our results will give two order of contributions:

a. a specific codification of some critical connections and
b. some interesting implications regarding the following items:

1. Configuration of biotechnology firms' relational and integrative capabilities and value implications.
2. Evidence in terms of process-position-path and (organizational) convergence solutions.
3. Intangible assets at the base of strategic processes in biotech firms.
4. Basic vs applied research networks: governance and incentive issues.

Item number 1: we found that scientists in the four biotechnology firms we studied enter into a large numbers of collaborative research efforts with scientists from other organizations, especially universities. Formally, market contracts are used to govern these exchanges of scientific knowledge, yet a sizeable portion of value is accumulated around few critical connectors through informal relations.

Item number 2: as required by the DCs theoretical framework, we organize data on the three dimensions of process-position-path. Within this framework, the cases appear in their complexity but what is interesting is the fact that they adopt common organizational solutions to a wide application of reputation management.

Item number 3: a direct consequence of the previously mentioned item 2, concerning the use of reputation as an intangible, strategic tool.

Item number 4: in a network dominion, rents are distributed more effectively if considered on the basis of reciprocity. This consideration may change the incentives mode and, consequently, address governance behavior.

Finally, our research findings point to the dominant use of boundary-spanning[1] social networks by the four biotech firms. This configuration increases both their learning and their flexibility in ways that would not be possible within a self-contained hierarchical organization. In such an environment, reputation is a key-management tool to know and use and it may be considered an intangible asset for the strategic process.

In order to provide effective support to the relationship between basic and applied research in the field of biotechnologies, it will be important to consider the role of the State as creator of conducive environments for selecting "social value".

This thesis is divided into the following sections. **In chapter I,** the research topic is presented as an empirical, real-changing movement, drawing on the case of USA and its national biotech-innovation system, in other words the change in the relational dynamic between basic and applied research. As such, the formulation of the general research question emerges out of a simple consideration of the corresponding problem for the Italian context, specifically southern Italy. **Chapter II** deals with the method and research questions and describes the modes of organizing the analysis. As the method is qualitative and focused on case studies, this section also presents the theoretical issues we referred to for data analysis and evidence discussion. We refer, here, to the dynamic capabilities theoretical approach presented mainly in two fundamental articles by Teece et al. on 1997 and by Teece on 2007.

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In Chapter IV the findings are grouped in three key-issues: configuration of BFs' relational and integrative capabilities and value implications, evidence in terms of process-position-path and (organizational) convergence solutions, basic vs applied research networks: governance and incentive issues. Finally, there will be the ending notes and the future research agenda.

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[1] We use the term boundary-spanning networks to refer to those networks in which the connecting role played by some critical nodes may be expressed not only in transferring knowledge, but also in translating and transforming it. The term is more frequently used in organization and strategic papers (see for example Carlile, 2004).

CHAPTER 1 – GENERAL RESEARCH TARGET

1.1 Basic vs applied research: a changing environment

Over the past decade there has been, for USA, a remarkable shift in the division of labor of R&D process among universities, industry and the federal government.

This transformation is most pronounced in the life sciences and the commercial fields of medicine, pharmaceuticals, and biotechnology. The post-cold war focus of federal science and technology policy on "competitiveness" has been noted by many observers, and the intensified interest in basic research and collaborative product development by large private corporations in various high-technology fields has been widely studied.

The accompanying change in the mandate of research universities toward a greater focus on commercializing research findings is understood from more recent contributions (Powell, Owen-Smith 2000). Throughout much of the post-World War II era there was a relatively clear distinction between basic and applied research, with the former the domain of the university and the latter the turf of business. The federal government, outside of defense-related research, supported the creation of an infrastructure for basic research and, through the National Science Foundation (NSF) and the National Institutes of Health (NIH), funded individual scientists as well. University research was basic in the sense that it aimed to understand phenomena at a fundamental level. The NSF defines basic science as research whose objective is a fuller knowledge or understanding of the subject under study, rather than a practical application thereof. So, universities focused more on the R side of R&D continuum, while much of industry eschewed basic research because the payoffs were either too long-run or difficult to appropriate. The great bulk of industrial R&D was focused on shorter-term problem solving. With the ending of four decades of rivalry and conflict with the Soviet Union, the rationale for federal science and technology expenditures has been reoriented toward programs that enhance economic "competitiveness" (NAS 1992; Cohen and Noll 1994; Slaugther and Rhoades 1996).

There is a growing federal view that research universities can and should play a larger and more direct role in assisting industry and promoting national competitiveness. Universities are being urged by federal government to seek more direct partnership with business in the development and commercialization of new technologies.

The shift in federal policy – from basic research to increased concern over its application – is reflected in legislation, funding plans, and joint agreements. These legislative changes sparked a considerable upsurge in licensing, as well as rapid growth in the number of university-industry research centers, cooperative research and development agreements, federally funded research and development centers, and industry-university research consortia. Accompanying these initiatives has been significant change in funding policies. At the NSF, numerous programs have been developed to promote university-industry collaboration, and

funding in some engineering and science and technology fields requires that NSF-supported centers have an industrial component.
The life sciences represent the cutting edge of these developments, in part because of the large number of start-up companies created with the assistance or direct involvement of academic researchers (Zucker, Darby and Brewer 1994). The biotechnology industry is remarkably clustered in but few areas – San Diego, The Bay Area, Boston, Seattle and Philadelphia and Houston – with close proximity to major universities, research-oriented hospitals, and cancer-treatment facilities. Physical, intellectual and economic integration between firms and universities is so pronounced that they constitute a common technological community (Powell 1996). One reason that the life sciences are rather unusual is that biotechnology represents a novel case of an industry that was developed inside the university[2]. The initial discoveries were made by university scientists, who then also played a leading role in the introduction and development of the new ideas. Biotechnology has thus largely collapsed the distinction between basic and applied science: fundamental new discoveries, such as gene therapy, have immediate scientific and medical importance as well as enormous commercial relevance (Powell, Owen-Smith, 2000) [3].
The Italian system of governance in research is, likewise, in need of a change in the division of labor between universities, industry and the national government. The central problem lies, more or less, in the inefficiency of public research institutions (University may be considered "under construction" at this point in time) and the low grade of investment in R&D on the part of private industry. This consideration could be understood as an abstract and pointless criticism but, even in its general formulation, it brings our initial attention onto a deeper analysis of certain aspects of our research system.
Starting from the case of biotechnology, it may be interesting to explore whether the Italian research system is apparently geared toward real integration between basic and applied research.
Without any doubt, the changing movement of the global competitive scenario is forcing many countries whose economies are based on the development of traditional industries, such as Italy, to shift the attention of their industrial policy toward research-based sectors.
Not surprisingly, the biotechnology industry is considered one of the most important strategic sectors for the competitive re-positioning of the Italian economy. While the bulk of biotech firms are clustered in Italy's northern regions, biotech initiatives are significantly lagging behind in the rest of the country. In other words, the Italian biotech industry can best be described by drawing on two fundamental references; one is our previous research[4], the aim of which is to provide a new data base consistent with OECD statistical standards, and a second work

[2] For a wider explanation of the relationships between science and technology and of the subsequent implications for growth theory, see Nelson, Rosenberg, 1999.

[3] The evidence is provided in Powell, Owen-Smith 2000, and is demonstrated by using data on university patenting and royalties derived from university licensing, and also by showing the increased role of industry funding of university research in the field of health-sciences as well as the noticeable changes in the labor market for the biological scientist. Finally, two universities at the forefront of research in the life sciences and its commercialization are viewed.

[4] D'Amore, R. and Vittoria, M.P. (2010) 'Assessing statistical standards for emerging industries. Applying OECD statistical codes to Italian biotech population lists', *World Review of Science, Technology and Sustainable Development (InderScience)*, Vol. 6, Nos. 2/3/4, pp.233–243.

developed within a STOA Master's course (2009)[5]. The former shows the distribution of Italian biotech firms consisting mainly of R&D units, as represented by academic research centers (tab. 1).

Table 1: Italian biotech firm distribution, 2005

Firm typologies	Profit	No Profit	total
Active & Innovative BFs	189	1	
Dedicated BFs	61		
tot			251
R&D	58	278	
targeted	83		
Other services	110	85	
tot			614

Source: D'Amore, Vittoria, 2010

Table 1 shows that the Italian biotech industry is essentially made up of service activities (70%), of which 45% are non-profit R&D biotech firms (essentially academic research centers) followed by other service firms (these include environmental service firms and other non-profit organizations such as local environmental agencies, scientific and technological/technology parks, public foundations, etc.), and finally by targeted firms (13%) acting solely as suppliers of biotech product/processes. Profit-making R&D biotech firms are less numerous and include research enterprises located in scientific and technological/technology parks or private laboratories acting in specific market segments.
As regards production activities, the main operator is the innovative firm (55%), a category which includes established firms already acting in other sectors (pharmaceutical or chemical) that adopt biotech innovations. This production constellation means that, in Italy, it is easier to find the innovative biotech adopters within established firms rather than in new, biotech-focused activities.

What emerges from the second analysis of the southern Italy biotech context is the weakness of the local R&D system in terms of the low rate of investment in research. The data show the low incidence of industrial investment in R&D and a greater portion from public research (also expressed in terms of number of employees).

A useful synthesis of the results of the above-mentioned research is shown in table 2.

[5] We specifically refer, here, to a research study conducted on the STOA Master in International and Local Development (MILD) on "Market Internationalization and Foreign Investment attraction: new opportunities and industries for local development. An insight into the Genetic Industry of Campania Region (ge.NET.work)".

Table 2: Swot analysis on genetic industry in Campania Region	
Strengths Public structural endowments in research; High-skilled human capital; Presence of a prestigious university and activation of specific degree courses; Specialization in red (medical) biotech.	**Weaknesses** Lack of coordination in public research and few ties with firms and institutions; Lack of managerial skills in research; Low level attractiveness of the territory; Few firms and small-sized enterprises; Low R&D investments; Lack of significant patents.
Opportunities Sector in constant growth; Private equity funding; Funding of New Community Program; Many sectors and productive activities involved in biotech applications.	**Threats** Brain drain; International new emerging competitors; Exclusion from the processes of knowledge diffusion.

Source: ge.NET.work, 2008. MILD/STOA'

What emerges from the evidence is a sector basically formed of R&D units and of targeted firms (data at national level) mainly clustered in Biotech Communities located in northern Italy, whilst the biotech sector in southern Italy is less developed in the number of both manufacturing and services firms. In Campania there are few but excellent research centers more oriented toward international research partners and far less connected with the local industrial base.
The question arising from these data concerns the reasons behind this weakness. In other words, is it a weakness due to the economic structure of southern Italy or, rather more subtly, is it due to the lack of real integration between the locus of research and Industry?[6]

1.2 General research target

The need for real change in the modes of connecting basic and applied biotech research is also testified by Italian and European government policies[7].

[6] The second part of the question may arise from a research perspective of industrial policy that finds justifications for governmental intervention, beyond issues of market failure, in the strategic dimension and in meta-economic objectives (Bellandi, Di Tommaso 2006). The perspective may include a wider consideration of welfare in terms of social value. We will consider this approach in our concluding remarks.

[7] The EU is striving to create a single European Research Area that encourages knowledge transfer through networks of world-class European researchers. Cooperation between European countries is further encouraged through cutting-edge infrastructure and joint policy-making for research. The most concrete manifestation of EU research and innovation policy is the Seventh Framework Programme 2007-2013 (FP7).

There are four strands to FP7:

- Cooperation: this involves collaborative research in health, food, agriculture, fisheries, biotechnology, information and communication technologies, energy, the environment (including climate change), transport (including aeronautics), socioeconomic sciences and the humanities, space and security. It also covers nano-sciences, nano-technologies, materials and new production technologies;
- Ideas: the key element here is the establishment of the European Research Council, which funds frontier science;

National and regional policies in the field of research and Competitiveness for the period 2007-2013 include some fundamental interventions[8] that tend to harmonize with EU policies.
Specifically, if we look at life sciences and the more recent policies conducted for the biotech innovation system of southern Italy, we find the creation of Competence Centers. These may be considered, among the various policy tools, the most representative in this field. Since 2003, the Regional Competence Centers (GEAR, BIOTEKNET and DFM) have been created as a result of the National Operational Programme "Scientific Research, Technological Development, Higher Training" for 2000-2006. Its aim is to enhance research and innovation in southern Italy, support scientific and technological development in companies, strengthen centers of excellence and human resources in the areas of research, principally science and technology. In other words, their mission is to match the contexts of basic and applied research expressed in terms of the distance between University and Industry research.

In such a scenario, our attention is centered on the "locus" of integration between basic and applied research in the field of biotechnology, whilst our research question focuses on the fitness/suitability of the organization to integrate basic and applied research resources located in southern Italy (see fig.1).

1.3 Basic and applied research in the innovation process: modeling and definitions

To conclude this section, we give, firstly, a current conceptual distinction among basic, applied research and development[9]. And than, some notes about the models that describe the innovation process. Although in the next section we will discuss, more extensively, about the theoretical yardsticks which gave rise to the more recent debate on the role of basic and applied research in the innovation process, here we start from the following, generic, definitions:

- People: this covers human resources and includes scholarships for young researchers, fellowships for lifelong training and career development, partnerships between industry and academia and awards for excellence;
- Capacities: funding here upgrades research infrastructures, supports research and development by small businesses, develops knowledge and science clusters and promotes scientific knowledge in general.

In order to meet the objectives of the renewed Lisbon strategy, and thus stimulate growth and employment in Europe, a Competitiveness and Innovation Framework Programme (CIP) has been adopted for the period 2007-2013. The Programme supports measures to strengthen competitiveness and innovation capacity in the European Union. It particularly encourages the use of information technologies, environmental technologies and renewable energy sources.

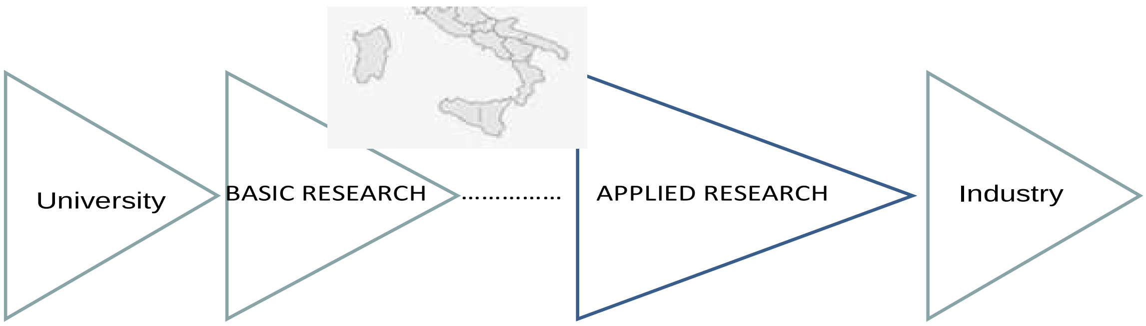
[8] We refer to the National Strategic Plan (QSN) and the National Operation Programme (PON) Research and Competitiveness, while regional policy is summarized in the Operational Programme sub European FESR and in the Action Plan for Regional Economic Development (Paser).

[9] The most important official source in this field is "OECD (1962), *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development,* DAS/PD/62.47". The so-called OECD Frascati manual. Adopted by member countries in 1963, the manual is a methodological document for conducting surveys on research and development (R&D). It has been revised several times. In 2002 the 6th edition was published.

Basic research: it is a research activity which aims to achieve knowledge without direct application purposes, based on pure intellectual curiosity and a willingness to discover the fundamental laws that explain the phenomena of nature.
Basic research explores what is unknown, extending the field as possible, and produce general and theoretical knowledge.

Figure 1

General research target



Source: our elaboration

Applied research**:** it is a research activity designed to achieve specific results applications, and explore ways and alternative methods for achieving practical ends. It produces models, methods and prototypes.
Development: It is the efforts to move from prototype to the proper production phase. This phase involves a search of details that usually ends up absorbing large amounts of economic resources.
Obviously the development is carried out mainly by the industrial firms and based on a commercial purpose, that is, with the aim of creating a new product to sell or a new technology to be applied in the production process.
The literature of economics of innovation has long been to study the phases of the innovation process. Many scholars have systematized the stages needed for a scientific discovery to reach the market. Since the variation of characters in science, technology as well as of the market (in the new needs of the customers), these phases are provided in a linear sequence (basic research-applied research-development-production-market) or non-linear (i.e. integrated, with a central role of design, or with frequent feedbacks). What happened in the case of

biotechnology - which we discussed in section 1.1 - has impacted on the process of many new products or processes.

The change has led to the possibility of selling the results of basic research.

This does not mean that it was eliminated the need for applied research. It is impossible to deny the fundamental linearity of the innovation process of many bio-pharmaceutical products/processes. But it means that it was added new actors/firms in the same process. This is very clear in the case of sequencing (see an evidence in the box below. It concerns the famous case involving two different actors – public and private research networks – in the race to decode the entire human genome. We have already talk about it in the introduction to the present paper. Now, it is important to note how the economies of scale in basic research – see the introduction of new machines for sequencing and the entrepreneurial ability of a scientist – may impact on the performances. This history also witnesses the critical role of intellectual property regime and how it may be overwhelmed – or at least – integrated by scientific reputation).

Until sequencing was performed manually, the project to decode the entire human genome had seemed a fantasy. But with the advent of automated techniques, influent people began to support the feasibility and utility. In 1986 Nobel laureate Renato Dulbecco appealed to the U.S. government to support this effort to support cancer research. In Great Britain, Sydney Brenner - future winner of a Nobel Prize - urged the EU to do likewise. The Department of Energy of the United States of America, which had been commissioned to study the effects of radiation on DNA, seized the opportunity and declared in 1986 that "knowledge of the human genome is so necessary for the continued progress medicine and other health sciences as knowledge of human anatomy has been for the current medicine".

But other scientists and other institutions such as the National Institute of Health in the United States were skeptical, some consider the task too ambitious and costly, others thinking that it would distract from other financial and intellectual capital research in genetics more feasible. At the end of the decade, the decision had been taken. The international Human Genome Project, funded by governments and charities, was launched in 1990 under the leadership of James Watson. He aims to decode the 3 billion base pairs, which are written in the genetic instructions of humanity, a view that would have required, according to its makers, 15 years of work and $ 3 billion. The project was of such large proportions that the last thing that we could expect was the competition. Yet in 1998, when the public consortium had deciphered only 3% of the code, the private sector launched the challenge. Craig Venter, the geneticist who had identified more genes than anyone else, concluded a transaction of 300 million dollars with the largest producer of machines for sequencing DNA in order to produce its version of the genome. With a new technique he invented, called "shot" sequencing of the entire genome, his company called Celera, promised to finish in just 2-3 years, long before the scheduled date of completion of the public project. Watson had won the first major competition of genetic era - in 1957 - having discovered the structure of DNA. Now he was about to start another competition, which would prove to be one of the most sharp disputes of the modern era.

The human genome is too large to be read in one single stroke. Therefore, was to be separated into sections appropriate to the capacity of the sequencing machines and the two rival groups faced this problem in two different ways.

... If the two groups were separated only by different professional approach would have been possible a relationship of cordiality. But they had a different worldview. The Human Genome Project saw the genetic code as a universal property of mankind and record the results in a public database, GenBank, as soon as they were available. Celera: there it was to obtain profits.

Although Venter had forced its lenders to freely publish their data, he also had a deal to manage. Celera hoped to sell access to a powerful database of genes, complete of software, which companies could use to find new genes and create new drugs. University researchers could have free access by paying, however, the rights to all commercial products created through the database.

This was an anathema to scientists such as John Sulston, who led the British contribution to the public project. They regarded Venter as a kind of pirate of gene, who tried to steal something that belonged to all in order to gain benefits for himself and for his funders. Although Venter always declare that the genome could not be patented, there was concern that Celera would try to privatizing it. The Human Genome Project accelerated its efforts, hoping to block any attempt at privatization, making the data available to all before his rival could claim rights.

Celera kept his word and made public its results, and its database was so useful that the majority of public scientific institutions and pharmaceutical companies will subscribe. The change of movement of the public project, however, precluded any possibility that the genome was patented. In 2004, after Venter had broken with its lenders and had resigned from Celera, the genome as a reference was even added to GenBank, free from any restriction of access. The genome war was over and the fierce rivalry had been useful to mankind. The stimulus of competition meant that the genome was sequenced much faster than anyone could have believed possible ten years before.

Source: Henderson, 2008

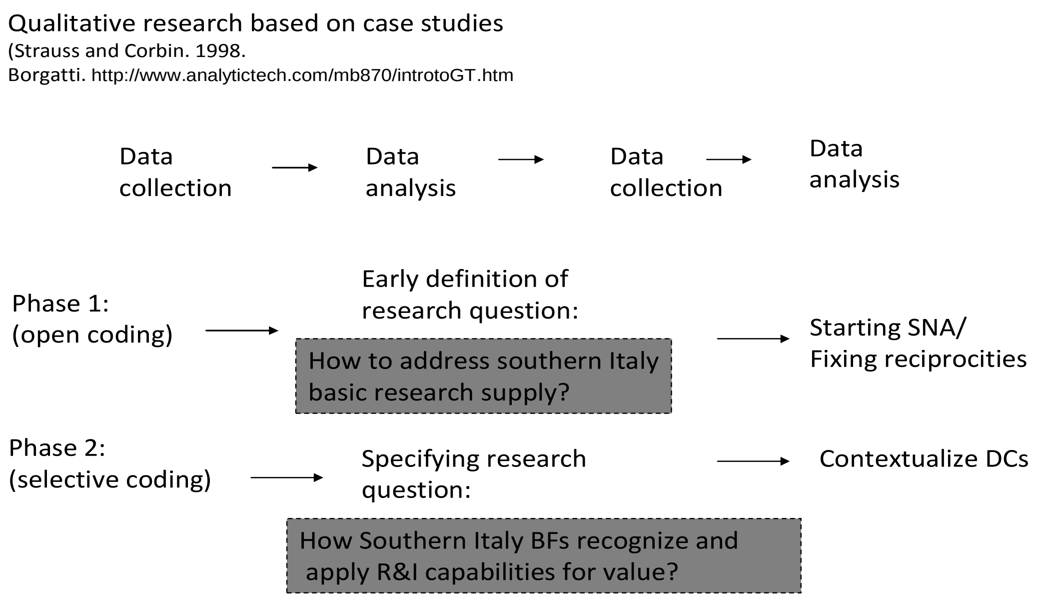
CHAPTER 2 – THE RESEARCH PROCESS

The present section is dedicated to expose our research process. As an inductive/qualitative methodological approach, it has been characterized by a previous knowledge of the subjects being investigated. More precisely, the research process, summarized in fig. 2, has been characterized by a substantial alternation between the phases of data collection and analysis.
The research method was largely dictated by the nature of research problem. We set out to study the dynamics of relations between public research organizations (PROs) and industry in biotechnology, where the classical setting which consider basic and applied research in a clear cut division between the two kind of actors probably is changing. The incoming relational dimension (more in terms of social processes) which account for the efficiency of basic and applied research flow, is not jet explored for southern Italy biotechnologies' research system. In addition, it was our intention to define more precisely the nature of intra and inter-organizational relations of the constituent groupings within this class.
The emergent and complex nature of these issues did not favor the quantitative investigation. In our view a qualitative approach was more appropriate because of the processual/dynamic nature of the phenomenon investigated (Bryman, 1999). In other words, we expect that the phenomenon is going through an evolutionary/critical phase, as already happens in other countries (USA), but we certainly do not know how the relationship between basic and applied research in this field are explicit in our country. We also know that using a theoretical framework such as the DCs can function to interpret and understand the basic research problem (on regard of emergent organization of R&D in biotech field) but that the research process should be complemented by additional analytical tools that help the specific exploration of relationship dynamics.
The text that follows will be organized starting from an analysis of the theoretical arguments that the literature has offered on the issue of relations between basic and applied research in the innovation process. Then, will be showed the process of construction of the "derived research logic" as the algorithm for the exploration of the case studies.

2.1 Basic AND applied research for innovation: theoretical issues and open problems

Innovation economics is based on the identification of the inventive process with Research and Development (R&D) activities or, better with the complex activities it was agreed to collect and statistically define R&D activities (Antonelli, 1982). As we have seen in the previous chapter, there is, on this issue, the most important statistical reference in the OECD Frascati Manual. It represents a massive rationale to set indicators, limits and deviations. So we have, among the inputs of the R&D process, the research expenditures, the number of employee, etc, while, among the outputs, the number of patents and the number of new products introduced in the marketplace.

Figure 2: The research process



Source: our elaboration

On regard of research on innovation, the economists have overly focused on just one variable: the degree of market power that a firm or firms may have.

Schumpeter was among the first to declare that perfect competition was incompatible with innovation. In particular, schumpeterian position, as advanced by Kamien and Swartz (1982), is that innovation is greater in monopolistic industries than in competitive ones because innovators with monopoly power can use this power to exclude imitators, and the resulting higher profits can be used to finance R&D[10]. The Schumpeterian trade-off between firm size, degree of market concentration and innovation was, for long time, largely accepted together with the consideration that market mechanisms do not yield an optimal resource allocation for innovative activities[11].

[10] In addition, large firms are considered more innovative than small firms because there are economies of scale in R&D, because large firms are better able to exploit unforeseen innovations, and because indivisibilities in cost-reducing innovations make them more profitable for large firms (Teece, 1999).

[11] The public nature of technology implies that profit-motivated agents will not undertake costly research if their outcome can be appropriated by other competing agents. Underinvestment in innovative activities as compared to the social optimum will result as a consequence. On the other hand, a private monopolist, unthreatened by potential entrants, will also engage in insufficient research. Fixed costs and indivisibilities are by definition sources

Thus, the role of institutions as the patent system or the involvement of the government in support of innovative activities can therefore be discussed and justified. On the same level of analysis, the consideration of the market failures associated with the exchange and evaluation of technical information provides the basis for understanding some important features of the organization of research activities, such as the relative advantages of internalizing R&D within firms as opposed to its decentralization in specialized organizations selling their research in the marketplace (Mowery, 1983), or the relative efficiency of small and large companies in generating innovations (Arrow, 1983). Following this approach, by considering technology as information about the methods of production of any one good (Arrow, 1962; Dasgupta, 1988; Dasgupta, Stoneman, 1987), consequently, as a durable public good, once produced, **technology is freely available to everybody**, private producers of technical knowledge would not be able to appropriate the value of their output fully. Here the rate of innovation and market structure, in any one industry, can be analyzed as the equilibrium outcome of a race for the acquisition of valuable information among profit-maximizing competing agents, and the utilization of game-theoretic methods as analytical devices to investigate them. The analysis of innovative activities is viewed as a rational decision to allocate resources to the acquisition of information in a market context[12] [13].

Starting from this position but gradually moving away from it, there were a great bulk of studies that showed the enormous number of variables that can potentially intervene between the generation of monopolistic rents and the allocation of resources to the development of new products and processes[14].

The debate was, mainly, focused on the more complex nature of technology and innovative activities. Particularly,

a. the deeper exploration of the complex word of basic and applied research, for long time considered the "black box" of economic models, started with the fundamental book of Nathan Rosenberg (1982) (and with the subsequent publications of Rosenberg, 1994; Rosenberg and Nelson, 1994, Nelson and Rosenberg, 1999), on the state of scientific knowledge and its relationship with technology. These researches have led the economists to recognize the endogeneity of science in economy's development (i.e. the contribution of scientific advance to the promotion of technology is basically a byproduct of the scientific enterprise and, more, by creating new knowledge, Science, almost inadvertently sheds light on certain technological problems, and spotlights certain technological opportunities that had not be seen before). And, more, they led to the suggestion to adopt, in the formal growth model, an evolutionary approach to the role of technological change.

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of scale economies. Uncertainty entails again a suboptimal resource allocation to innovative activities in the absence of a complete set of contingency markets (Schumpeter, 1934; 1942; Arrow, 1962).

[12] The properties of the solution are than a function of variables related to the nature of the competitive threats and incentives implied by market structure and by some features of technology: the expected profitability of the innovation, the size of the demand for the products of the industry, the risk of being pre-empted by competitors, the degree to which the revenues from innovation can be reaped by the innovator or can be earned by imitators, the level and structure of R&D costs, etc.

[13] In particular, science and technology can, in principle, be considered as social organizations which differ only in terms of the goals that guide them. Science implies complete publicness of the results of the research, whilst technology entails the private appropriation of such results and therefore encourages secrecy.

[14] For an overview, see Freeman (1982), Pavitt (1987), Dosi (1988).

b. Technology, far from being a public good, involves also important private aspects which are related not only to the protection provided by patents and secrecy but also to its tacit and specific nature. As a consequence, the transfer of technical knowledge is costly, time-consuming and difficult (Pavitt, 1987).
c. Technological advances are built upon some portion of publicly available knowledge – which may be located in universities, other research institutions or other industries and firms –and upon the development of the internal, specific and tacit capabilities of any one company (Orsenigo, 1989).
d. Innovative activities involve differentiated learning procedures which range from highly formalized R&D to informal processes of learning-by-doing and-using, to design, production engineering, etc. (David, 1975; Rosenberg, 1982). The search for new technical solutions involves a high degree of coordination and interdependence among all these learning activities and other different corporate functions.

At the downstream of these contributions there were a wide acceptation of the fact that the organizational and institutional system supporting innovation has become increasingly complex, involving a variety of agents and institutions and highly articulated relationships between them (Freeman, 1987; Nelson, 1986).
What emerges, at this point, as a necessary upgrade, is that market structure, considered until now the first explicative variable of the technical change, become in itself an endogenous variable of the same process. The technical advance becomes in partly shaped by the past history of success and failures in innovation and by the specific properties of the relevant technology (Nelson, Winter, 1982; Dosi, 1984).
In order to capture these features of the process of innovation, the notions of technological paradigms and trajectories[15] (Dosi, 1982; 1984) and of technological regimes[16] (Nelson, Winter, 1982) have been proposed as conceptual tools for the analysis of the determinants and procedures of technical change. Market mechanisms affect the rate and directions of technological advances within the boundaries of any one paradigm.
Following these ideas, is reinforced the belief that the underlying properties of technological innovation, generally applicable, might lead toward the identification of organizational requirements of innovation process.

Emerging frameworks in innovation economics, in this phase, tend to shift the market structure-innovation debate toward a new domain where internal structure and interfirm agreements attain new significance. It finds many criticisms in the same monopoly structure and in the subsequent financial need at the base of innovation: with or without the internal cash flow, there is the inefficiency of capital markets. The Schumpeterian view of the innovation process appears to be one that involves full integration, from research, development, manufacturing

[15] A technological paradigm can be defined as a pattern of solution of selected techno-economic problems based on highly selected principles derived from the natural sciences (Dosi, 1982; 1988).

[16] The notion of technological regimes provides the basis for the analysis of the sectoral differences in the determinants and procedures of innovative activities. In this view, each technology can be characterized as a specific combination of particular knowledge bases, sources and degrees of technological opportunities, conditions of appropriability, forms and degrees of cumulativeness of technological advances.
A more wider conceptualization will be given by Nelson (1993) in showing that technological development is considered a location-specific phenomenon, rooted in the skills, capabilities and knowledge that accumulate over time in the National Innovation System (NIS). Many research contributions will follow it. Specifically for biotechnologies (see Bartholomew, 1997).

and marketing. But the financial requirements associated with developing and commercializing new products and processes can be accomplished with myriad organizational arrangements including research joint ventures, coproduction, and comarketing arrangements. With such arrangements, there is the possibility that the capital requirements associated with a new project could be drastically reduced for the innovator. Economies of scale and scope can often be captured through interfirm arrangements.

Among the discussed properties of technological innovation, the aspects of uncertainty[17], path dependency[18], cumulative nature[19], irreversibilities, technological interrelatedness[20], tacitness[21], inappropriability[22] are identified by the literature (Teece, 1999).

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[17] "There are various kind of uncertainty. Koopmans (1957) has made a useful distinction between primary and secondary uncertainty. Both are critical in the context of innovation. Primary uncertainty arises from "random acts of nature and unpredictable changes in concurrent preferences" (Koopmans, 1957. Pg. 162-3); secondary uncertainty arises from "lack of communication, that is, from one decision-maker having no-way of finding out the concurrent decisions and plans made by others". Williamson recognizes a third kind of uncertainty, what he calls behavioral uncertainty, attributable to opportunism….It is important to note that secondary uncertainty can be affected by changing the boundaries of the organization" (Teece, 1999. Pg. 135).

[18] "Technology often evolves in certain path-dependent ways, contoured and channeled by what might be thought of as technological paradigms (Dosi, 1982). A technological paradigm is a pattern of solutions to selected technical problems which derives from certain engineering relationships. A paradigm identifies the problems that have to be solved and the way to inquire about them; within a paradigm, research efforts become channeled along certain trajectories. Relatedly, new product and processes developments for a particular organization are likely to lie in the technological neighborhood of previous successes" (Teece, 1999. Pg. 136).

[19] "Technological development, particularly inside a particular paradigm, proceeds cumulatively along the path defined by the paradigm. The fact that technological progress builds on what went before, and that much of it is tacit and proprietary, means that it usually has significant organization-specific dimensions. Moreover, an organization's technical capabilities are likely to be "close in" to previous technological accomplishments" (Teece, 1999. Pg. 136).

[20] "Innovation is characterized by technological interrelatedness between various subsystems. Linkages to other technologies, to complementary assets, and to users must be maintained if innovation is to be successful. If recognizable organizational subunits such as R&D, manufacturing and marketing exist, they must be in close and continuous communication and engage in mutual adaptation if innovation in commercially relevant products and processes is to have a chance of succeeding. Moreover, successful commercial innovation usually requires quick decision making and close coupling and coordination among research, development, manufacturing, sales and service. Put differently, organizational capacities must exist to enable these activities to occur with dispatch" (Teece, 1999. Pg. 136).

[21] "The knowledge developed by organizations is often highly tacit. That is, it is difficult if not impossible to articulate and codify (Polanyi, 1962; Winter, 1987). A corollary is that technology transfer is often difficult without the transfer of key individuals. This simultaneously explains why imitation is often costly, and why the diffusion of new technology often depends on the mobility of engineers and scientists (Teece, 1977; Nelson, Winter, 1982). Relatedly, an organization's technology ought not be thought of as residing in some hypothetical book of blueprints, or with some hypothetical chief engineer, but in an organization's system and habits of coordinating and managing tasks. These systems and habits have been referred to as organizational routines (Nelson, Winter, 1982). It is the performance of these routines that is at the essence of an organization's technological capacity" (Teece, 1999. Pg. 136-7).

[22] "Under many legal systems, the ownership rights associated with technical know-how are often ambiguous, do not always permit rewards that match contribution, vary in the degree of exclusion they permit (often according to the innate patentability or copyrightability of the object or subject matter) and are temporary. ….Relatedly, the absence of good legal protection presents what Arrow has referred to as the "fundamental paradox of information". In order to provide full information to the buyer, the seller of know-how may have to disclose the object of the exchange, but in so doing the basis for the exchange evaporates, or at least erodes, as the potential buyer might now have in its possession that which he was seeking to acquire. Hence, transactions in the market for know-how must thus proceed under conditions of ignorance. Accordingly, at least until reputations become established, exchange is likely to be exposed to hazards. Optimal resource allocation is unlikely to result" (Teece, 1999. Pg. 137).

Many organizational distortions (such as bureaucratic decision making, principal-agent problems, the trap of an increasing myopia of individuals in organizations, the organizational culture and values, etc.[23]) may impact with firm-level innovation. And the need for a deep analysis of the innovation process emerge. Studies are carried on that show the different implications between organizational structure and innovation.
As consequence, a growing research interest on the better organizational modes for value creation in this field, is the result.

If distinctive governance modes may arise, a new assessment for the innovation process occur, very different from that of Schumpeterian view. In other words, these approach suggest to address much attention from the problems occurring in term of

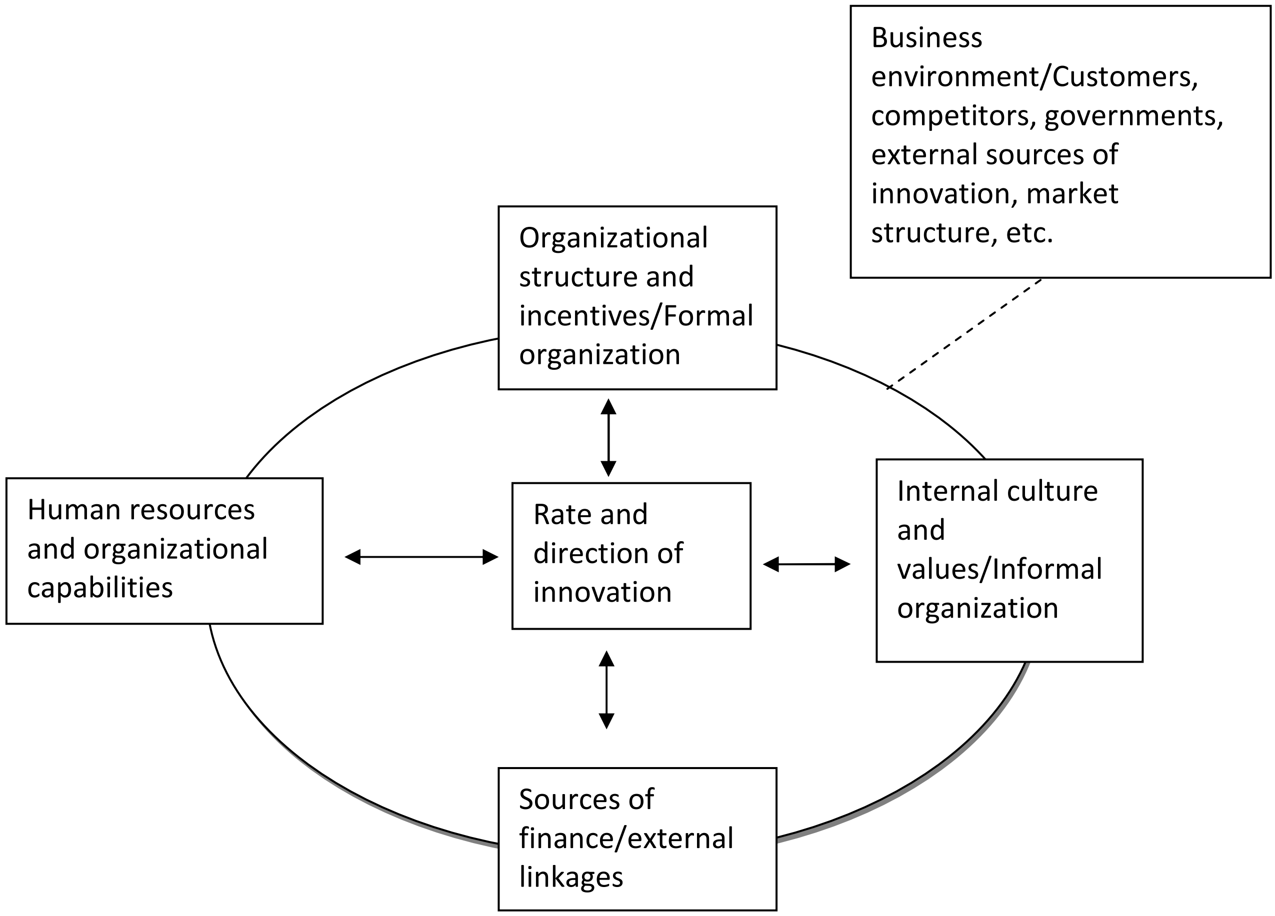
1) division of labor in R&D process/firm boundaries,
2) toward the different problem of organization (internal formal structure, internal informal structure, external linkages) and to a more deep analysis of
3) strategic management" (Teece, 1999).

This research approach states the critical importance of the link between the innovative potential and the organizational structure. The current research need goes toward a more deep comprehension of this relation by discussing the above mentioned implications (see points 1, 2 and 3). The emerging, richer framework of the innovation process pay greater attention to organizational structure, both formal and informal and to recognize the importance of market structure and the business environment (see figure 3).

Among the various organizational structures that are investigated, as the main referred, the case of the individual inventor and/or the stand-alone laboratory is to consider with more attention for our analysis. In fact, as we have said and hopefully will discuss in this text, the changing process that was introduced with biotechnologies has impacted strongly on the theory of the innovation. The *brand* of this technological breakthrough may be expressed in terms of the *new possibilities for scientists to become entrepreneurs*.
When this "marketable basic research" emerged, many problems for the inventor-entrepreneur also raised. These problems refer, basically, to patent assessment and to the concomitant leakage problems which this process exposes. In particular, when an inventor (or an enterprise) can rely on the instruments of intellectual property protection to protect invention from imitation, we know that the inventor can appropriate a substantial portion of the inventor's market value. When property rights are weak (the normal case), the inventors' ability to capture value are dramatically circumvented (Teece, 1986). In the case where the individual inventor has a patent but little else, then the patent-holder's options include: a) licensing the technology to incumbent firms who already have the necessary complementary assets in place; b) using the patent as collateral to raise debt funds to help develop an organization to exploit the technology; c) exchanging the patent for equity in a start-up, equity funded firm; d) exchanging the patent for equity in an established firm.

[23] To study in detail these argumentations, see Teece, 1999; 2007.

Figure 3: Determinants of the rate and direction of firm-level innovation



Source: Teece, 1999

In parallel, we know that none of these options avoid the problem of valuing the patent in itself and the Arrow paradox is verified. Or, in Arrow' words: "Its value for the purchaser is not known until he has the information, but then he has in effect acquired it without cost" (Arrow, 1974. pg. 152). While this problem is somewhat softened where there is good patent protection, most nonindustrial providers of funds are going to need technical experts to evaluate the technology, in which case the risk of leakage remains (Teece, 1999). Of course, if the problem involve an organization (a stand alone laboratory) instead of the individual inventor, or, if scale economies exist in R&D, different organizational skills may help to face the knowledge transition.

These argumentations let us consider that the current doctrinal paradigms that face these kind of problems, may be (basically) distinguished in two great research approach. They differ, in primis, in the mode of viewing the innovation process.
If we consider that ideas come from University or research center laboratories and that the firm represents the transition **from** basic **to** applied research where products are developed, this may illustrates the difference in role between non-profit research centers (where basic research is conducted), often at government expense and for-profit enterprises (where applied,

developmental research is conducted), often funded by investors (Narin et al., 1997) [24]. In R&D, the firm often acquires scientific knowledge from an academic sector, procures certain services from specialist firms, and forms an alliance with another firm(s) who has a different capability.
The capability theory explains this behavior. Transaction costs may arise in the use of outside resources.
Under these premises, research contributions (Odagiri, 2003) sustain the importance to refer to both theories, in the need to consider them not-mutually-exclusive on these issues: economies of scale and scope, transaction costs and capabilities are the three major determinants of the boundary of the firm, that is, of the boundary separating in-house R&D and procured R&D.
By the other hand, if we consider that ideas may arise in a place not-pre-determined but that may arise or converge in a relational interaction (often of informal nature) among different actors (co-specialization – assets to be employed in conjunction) , we have to turn our attention to the mode of capturing these ideas.
Here, the fundamental research question is no longer to investigate "who makes what", as to determine HOW the actors could strategically move **between** basic and applied research in a shared value creation process.

[24] Under this hypothesis the research focus on inter-industry differences in the relationship between university and industry. A line of research pioneered by Francis Narin and colleagues exploits information on references to scientific articles contained in patent documents, which shows an increasing reliance of private technology on public science (Narin and Noma 1985; Narin et al. 1997; McMillan et al. 2000; Hicks et al. 2001; Tijssen 2001; Branstetter and Ogura 2005). A related line of enquiry investigates the patterns of scientific paper co-authorship among academic and corporate scientists, and provides evidence of increasing levels of collaboration across organisational boundaries (Hicks 1995; Calvert and Patel 2003; Tijssen 2004). Many observers have raised concerns about the potentially negative effects of the commercialisation of scientific discoveries for the conduct of academic research. It has been argued that the financial incentives from patenting and licensing could shift the orientation of scientists away from basic and towards applied research and could undermine their commitment to the norms of open science, thereby leading to secrecy and publication delays. In order to address these issues, many scholars have begun to compile large data sets matching inventor names with scientific author names, and to collect data on individual researchers' patenting and publication performance (Azagra-Caro et al. 2006; Azoulay et al. 2006; Van Looy et al. 2006; Breschi et al. 2007, 2008; Calderini et al. 2007; Fabrizio and Minin 2008). Although no consensus has been reached, there is evidence that there is no apparent trade-off between patenting and either quantity or quality of research output. Not only do scientists with better patenting performance tend to exhibit superior publication scores with no decrease in the quality of output, but also the most productive scientists are those most likely to become inventors. A related stream of research focuses on the role of individual scientists in relation to knowledge spillovers from academic research and knowledge transfer from university to industry more broadly. The need for a better understanding of the mechanisms of knowledge flows has sparked several attempts to trace personal links between academic researchers and private firms. In this context, Cockburn and Henderson (1998) argue that the extent of connectedness to the community of open science is a key factor explaining the ability of firms to tap into scientific developments. Establishing linkages with the community of open science may crucially affect their capacity to recognise and effectively exploit upstream developments in basic research. Using qualitative information and data on scientific co-authorship, Cockburn and Henderson show that firms strive to develop this capacity by recruiting and rewarding researchers based on their ranking in the hierarchy of public-sector science and their ability to engage with the academic community. Finally, we believe that this approach may analyze only a portion of a wider phenomenon. If the problem is in reinforcing the whole innovation process (starting from basic to applied research), and if technology is in part tacit and unappropriable, there will be a need of a multiple and complex kind of relationality among the actors involved. It may express in various forms of connectedness and not only in the sharing of publications. This is well explained by Teece (1999) (see our text, note n. 22).

Scholars of the Dynamic Capabilities (DCs) view extended RBV to dynamic markets (Helfat and Peteraf, 2003; Helfat et al., 2007). These researchers doubt that the mere existence of appropriate bundles of specific resources is insufficient to sustain competitive advantage in situations involving rapid and unpredictable market change (Eisenhardt and Martin, 2000; Teece et al., 1997). Consequently, these researchers argue that dynamic capability, or the ability to integrate, build and reconfigure resources, is essential in learning competitive advantage under circumstances of environmental volatility (Eisenhardt and Martin, 2000; Newbert, 2005; Rindova and Kotha, 2001; Teece, 2007; Teece et al., 1997; Zollo and Winter, 2002).
In this conceptual transition (from RBV to DCs) there is the theoretical core issue for our analysis. Subsequently, in what follows we'll try to summarize the principal statements of both these two theoretical framework.

2.2 DCs' theoretical framework: main statements

The RBV theorize that firms possessing resources that are **v**aluable, **r**are, **in**imitable and non substitutable (i.e. resources with VRIN attributes) can achieve sustainable competitive advantage by implementing fresh value-creating strategies that are difficult for competitors to duplicate (Barney, 1986; Dierickx and Cool, 1989; Grant, 1991; Newbert, 2007; Uhlenbruck et al., 2006; Wernerfelt, 1984). The RBV has become a crucial logical consideration in firm strategy development. Consequently, accumulating resources to foster competitive advantage or economic rent has become fundamental to strategic thinking for numerous managers and scholars.
The pioneristic work of Penrose (1959) introduced the importance of viewing the firm as a collection of physical and human resources. These resources had to be accumulated by the firm to achieve growth. The competitive advantage, in other words, is captured through an entrepreneurial rent stemming from fundamental firm-level efficiency advantages. Many similarities are with Schumpeter (and to his fundamental definition of the competitive context), with his view on the role of innovation as source of competitive advantage. The central conceptual contribution is given by the consideration that resources are valuable only when they constitute *capabilities* which have to be enhanced through innovation and learning for the firm to grow.
From this perspective the process of identifying and developing the requisite assets is not particularly problematic. The process involves nothing more than choosing rationally among a well-defined set of investment alternatives. If assets are not already owned, they can be bought.
For our analytical purposes we point out, briefly, the RBV's entry decision process in the following phases:

a. Identify the firm's unique resources;

b. Decide in which markets those resources can earn the highest rents;

c. Decide whether the rents from those assets are most effectively utilized by α)integrating into related markets, β)selling the relevant intermediate output to related firms, or γ)selling the assets themselves to a firm in related businesses.

The RBV also point out the role of skill acquisition, the management of knowledge and know-how and learning as fundamental strategic issues when control over scarce resources is the source of economic profits.
In integrating the above mentioned framework[25], DCs view introduces, and emphasizes, the two key aspects of the dynamism and a more deeper analysis of organizational capabilities.
In particular, with the term *dynamic* they refer to the capacity to renew the competences so as to achieve congruence with the changing business environment. The term *capabilities* emphasizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and organizational skills, resources, and functional competences to match the requirements of a changing environment.
"There are many dimensions of the business firm that must be understood if one is to grasp firm-level distinctive competences/capabilities. In this paper we merely identify several classes of factors that will help determine a firm's distinctive competence and dynamic capabilities. We organize these in three categories: processes, positions and paths. The essence of competences and capabilities is embedded in organizational processes of one kind or another. But the content of these processes and the opportunities they afford for developing competitive advantage at any point in time are shaped significantly by the assets the firm possesses (internal and market) and by the evolutionary path it has adopted/inherited. Hence organizational processes, shaped by the firm's asset positions and modeled by its evolutionary and co-evolutionary paths, explain the essence of the firm's dynamic capabilities and its competitive advantage" (Teece, et al., 1997. Pg. 518).
Than, competence can provide competitive advantage and generate rents only if they are based on a collection of routines, skills, and complementary assets that are difficult to imitate.
In addition, posed the endogenous role of industrial structure, the framework states the priorities in the entry decision process in the following phases:

a. Capture the emerging marketplace trajectories;

b. Address it through new products, processes or services;

c. Managing threats and Reconfiguration

As consequence, the deep difference with the RBV is in the firm value definition: it is guaranteed not only by the firm's Unique Asset Base (UAB) but also by Dynamic Capabilities (DCs).

[25] Like RBV, the DCs approach is centrally concerned to wealth creation and capture (Teece, Pisano, Schuen, 1997). Its disciplinary foundation is evolutionary economics (Nelson, Winter, 1982). For this reason, it brings a process (dynamic) perspective to its firm conceptualization. More precisely, the DCs' theory of the firm is very consistent with Coase (1937) (to his firm definition as an alternative to market in the mode of governance) but not with the transaction costs (TCE) literature, greatly expanded by Williamson (1975; 1985). The main differences with TCE lying in the explanation of the selection of what organize internally or externally. While TCE main argumentation is the nontradability of specific assets, DCs look at assets co-specialization as the reason why assets are not traded. Here the focus is on the "orchestration" of co-specialized assets by strategic managers. The deep difference emerges then at methodological level: while TCE emphasized opportunistic free riding and a human actor boundedly rational, self-interest seeking, opportunistic, and full of guile, DCs adds other traits of human nature: intrapreneurship and entrepreneurship and foresight and acumen (Helfat et al., 2007). Operationally, it means that DCs data sources and methods are inductive theoretical tools, qualitative data, qualitative empirical analysis.

So the DC view point out the role of dynamic capabilities, mainly grouped in the above cited a, b, c behavioral dimensions, as the foundation of enterprise-level competitive advantage in regimes of rapid technological change.

Together (a, b and c) might be thought of as asset "orchestration" processes.

"A key strategic function of management is to find new value-enhancing combinations inside the enterprise, and between and amongst enterprises, and with supporting institutions external to the enterprise. Because many of the most valuable assets inside the firm are knowledge related and hence non-tradable, the coordination and integration of such assets create value that cannot be replicated in a market" (Teece, 2007. Pg. 1341).

Unfortunately, most DC research focuses solely on conceptual discussions (e.g. Deeds et al., 2000; Eisenhardt and Martin, 2000; Griffith and Harvey, 2001; Helfat et al., 2007; King and Tucci, 2002; Luo, 2000; Madhok and Osegowitsch, 2000; Majumdar, 2000; Makadok, 2001; Petroni, 1998; Rindova and Kotha, 2001; Teece, 2007; Teece et al., 1997; Zollo and Winter, 2002), and empirical studies are rare (e.g. Wu, 2006; 2007). Numerous concepts need examination and DC needs further discussion.

An open problem is represented by the priorities to attribute to each resource in discriminating competitive advantages.

The field of strategic management and dynamic capabilities framework recognize that "strategic fit" needs to be continuously achieved. The key dimension of *fit* emphasized in the DCs framework is that of *cospecialization.*

"Cospecialized assets are a particular class of complementary assets where the value of an asset is a function of its use in conjunction with other particular assets. With cospecialization, joint use is value enhancing" (Teece, 2007. pg. 1338).

A wide scientific debate emerges from the discussion about the nature of this kind of relation (cospecialization). Many research efforts has been dedicated to model the relationship between cospecialized and complementary assets. In particular, Lippman and Rumelt (1982) gave the first definition of causal ambiguity[26] to pose a problem of comprehension of logical-causal connections between actions and results. The problem involved both the intra-firm and inter-organization relations. They also proposed (Lippman, Rumelt, 2003a; 2003b) the concept of supermodularity to bring in the tools of cooperative game theory.

Teece (2007) suggests to consider the case of complete cospecialization as a special case of economies of scope, "where not only are complementary assets more valuable in joint use than in separate use, but they may, in fact, have zero value in separate use and high value in joint use. Cospecialization may stem from economies of scope, but they could also stem from the revenue enhancement associated with producing a bundled or integrated solution for the customer" (Teece, 2007. pg 1338).

Some suggest that DCs are actually simple and causal links between the resource or capability and the rent creation may be easy to establish (Eisenhardt, Martin, 2000).

Other research contributions overcome the problem by adopting an inductive methodological approach in which it is possible to observe directly the frequency of a specific behaviour.

[26] On this regard, we remember that the concept was used in the analysis of competition with respect to *uncertain imitability* (Lippman, Rumelt, 1982). Following this analysis, the ambiguity exists in the nature of basic assets and in the modes of interaction among them. This ambiguity may conduce to the impossibility in finding a value creation algorithm. More recent research (Blyler, Coff, 2003), addressed to benefits and rent allocation stemming from DCs, underline the importance of causal ambiguity contexts.

An interesting contribution on this issue is given by Fujimoto (1999). He faced firm evolutionary capabilities using the car industry in general, and Toyota in particular, as an example. “He extends the resource view of the firm to look in detail at how capabilities change over time, attempting to explain interregional and interfirm differences. Instead of applying the concepts of resource-based or capability theories on the firm as a unit, Fujimoto brings the analysis to the operational level. This approach has merit in that it serves to make the rather abstract notion of capabilities of the firm much more concrete. In the process, Fujimoto makes a compelling argument for not only interpreting capabilities as something directly affecting the level of competitive performance and the improvements of performance, but also as the accumulation of these static and improvement capabilities. In other words, successful firms are not only competitive and know how to improve to stay competitive, they also know how to sustain these skills over time; a concept not too dissimilar in spirit from double-loop learning or “learning how to learn”. His work goes on to explore in some depth this novel interpretation of evolutionary capability as a firm-specific ability to acquire both static and improvement capabilities” (Hagström, Chandler, 1999. pg.3).
On the field of operational determination of DCs, more recent literature (Helfat et al., 2007) have identified four important influences on the evolutionary fitness of dynamic capabilities: quality, cost, market demand, and competition. These works introduce the term “technical fitness” to capture the idea of quality per unit of cost, an internal measure of capability performance. The other two factors of market demand and competition capture important environmental influences on evolutionary fitness. Each of these factors affects the external fit of operational abilities as well as the evolutionary fitness of dynamic capabilities.

2.3 The research process

We conducted an exploratory study using a qualitative approach based on case studies. Consequently, we undertook an in-depth case study analysis of a limited number (four) of successful biotech research-based organizations conducting a participant observation through direct visits over a period of two years.
Documentary data (emerging from both their institutional memoranda, reports and official web sites) in conjunction with group interviews and observations have been our data sources.
The target was to obtain the information needed to built the comprehension of firm value creation process.
The following pages (grouped in chapter 2 and 3) will show the research process in both its alternating phases of data collection and analysis until the definition of our operational definition of firm value[27].

The **research process** starts out from a general research question and leads to a new theoretical insight in the field of network governance by alternating the phases of collection and data analysis. Two basic research phases can be distinguished:

- Open coding: guided by initial research questions (“how to address basic research supply in southern Italy?”), we collected the first set of data, and then analyzed the evidence. Here, our attention was on identifying the “positive experience” of a good

[27]The research process is very close to that of Grounded Theory of Strauss and Corbin (1998).

relationship between basic and applied research in the field of biotechnology. In this first phase we also look at the potential organizational fields in which we can observe and codify informal relations. We also started to use Social Network Analysis (SNA).

- Selective coding: the second set of data was collected after the first phase of data analysis. Here, we were guided by theoretical developments that had emerged during the analysis. We then tested for the presence of Relational and Integrative capabilities (R&ICs) in our case studies.

The specific research question arose from the *dynamic capability* (DC) theoretical model (Teece, Pisano, Shuen, 1997; Teece, 2007) and concerns the way in which research organizations recognize and apply Relational and Integrative Capabilities (R&ICs) (the most important dynamic capabilities in the biotechnology field) for value.
The following sections will focus on the presentation of our derived research logic.
As the DC theoretical framework has been chosen to study firm value and a relational analysis to explore the organization, we will consider the following: in section 2.4.1, the adequacy of DC theory to study our firms; in section 2.4.3, previous research that has supported us when considering R&ICs as the dominant expression of DC at firm-level. A short review of informal relations as well as the critical organizational dimension to undergird the empirical relational analysis, will be grouped in Chapter 3.

Findings, grouped in chapter 4, will be presented through a discussion on three key issues.
They will consist of a sum of evidence and theoretical assumptions that lead to the formulation of some logical propositions.
The conclusions, in the same chapter, will be expressed on two levels:

a) on regard of the specific research question, we can accept or refuse the implications of the theoretical framework;
b) on regard of general research target, we can give some policy addresses.

2.4 The construction of the derived research logic

2.4.1. DCs perspective to study biotech firms' value creation process

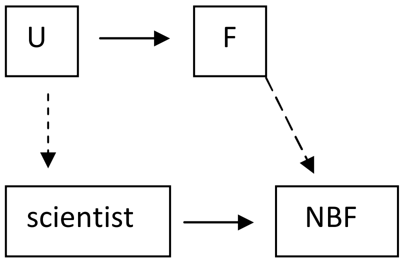
The early researches in biotech University-Industry complex world showed the emerging biotech industry as a real strength of USA economic system (Kenney, 1986). The new industry[28] was composed of the small scientific-entrepreneurial labs, very fragile during their first start-up phases, and much dependent from both the public and private financing (venture capital and stock exchange). In addition, the role of the state[29] was considered very crucial and was lying from the regulation until research funding.

[28] The US economic system may be considered the birthplace of biotechnological industry. On the birth pattern of this industry there may be country-specific factors in action (see Passaro, Vittoria, 1996a,b; Bartholomew, 1997). A specific analysis of the birth modes of biotech Italian firms is in Passaro, Vittoria, 2000.

[29] "The entire history of molecular biology is that of public funding of basic research that was meant to create the technical base necessary to understand and cure diseases….no corporation or group of corporations could have undertaken the research effort necessary to provide the knowledge base to create an industry. The uncertainty of payoff and long investment lead times were prohibitive. …Another crucial role for the state is that of validating new

Since biotechnology was born in the laboratories of American research universities the classical model describing the relation between basic and applied research as unidirectional direction was changing. University biology departments have been disrupted as great numbers of biologists have become entrepreneurs or at least deeply involved in commercial affairs. The creation of biotechnology industry was in large part due to the critical role of university professors. So the biotech innovation process may be viewed as a process that maintain the linearity of sequences from basic to applied research while the real change concerned the emerging role of basic research actors (see figure 4 below).

Figure 4: The biotech innovation process



Legend:
U = University
F= Firm
NBF = new biotech firm

Source: our elaboration

According to Kenney (1986), one of the most meaningful modes of creation of the new biotech firms (NBFs) was through the spin-off from academia of scientists who, following their professional experience, decided to create their own enterprise. The new firm, started on a research idea/project, was initially strictly dependent from external financial sources.
So, during that period, the real problem was to establish whether biotechnology would have survived as an industry as opposed to being merely a new tool in traditional industries (giant chemical and pharmaceutical companies more able to absorb the biotech start-ups). In effect, under country specific conditions, the strategic alliances (especially between the small biotech start-ups and large firms) increased very fast.
Transaction cost scholars (Williamson 1975; 1985) contended that alliances in this field was inherently transitory. They sustained that these alliances necessitated by a period of technological upheaval but soon to be replaced by (vertical) integration[30].
What will be important to move the attention of research community toward the more wide application of RBV on these issues, were the numerous articles dedicated to the explanation of

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areas of natural world as private property. (through the patent system) it permitted the patenting of a living organism *sui generis*, that is, it need not be part of a process" (Kenney, 1986. pg. 241-242).

[30] Their arguments varied from: the inevitable information asymmetries associated with knowledge-intensive sectors (Arrow, 1973); ex ante small numbers bargaining conditions; the tacitness of some knowledge components (Pisano, 1991); general uncertainty over intellectual property rights (Pisano, 1990); specific industry legislation (Pisano, 1991).

alliance formation in a different number of high-tech industries (like semiconductors). The underlying logic of alliance formation became, thus, for these industries, strategic needs and social opportunities (Eisenhardt, Schoonhoven, 1996) [31].

Subsequent research efforts were made in organizational science that were important to explore more deeply the alliance phenomenon in the biotech field (see Nohria, Eccles, 1992). Two important solicitations emerged from this wave of research: the observation of the quantitative increase in the number of biotech strategic alliances also in the international scenario (Barley, Freeman, Hybels, 1992) and the fundamental learning need at the base of the reason d'etre of some stable biotech networks (Powell, Brantley, 1992).

These researches have played the important function of recognizing the network as the organizational structure for biotechnologies and, more, they have established that alliances between NBFs and large manufacturing firms as the alternative solution to their financial recurring problem.

"After years of dependence on venture capital and public financing, the managers of dedicated biotech firms increasingly have turned to formal cooperative relationships for their vital resources. Many such relationships are with the leading firms in their own markets. As a result, networks of inter-organizational alliances have become integral to the structure of the biotech community. …Strategic alliances in biotechnology generally involve the exchange of knowledge for money. Often the exchange requires a smaller firm to sacrifice some degree of autonomy (for instance, over determining its goals for R&D) to gain access to markets with high barriers to entry. For many biotechnology firms, the compromise may forestall bankruptcy, merger, or acquisition." (Barley, Freeman, Hybels, 1992. Pg. 343-44)[32].

With the analysis of Powell and Brantley (1992), a key concern was whether one type of external linkage is a substitute for another type of linkage or complementary to it. They started to consider new biotech firms (NBF)[33] and the case in which, faced with competition from large,

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[31] Consistent with these explanations, it was found that alliances form when firms are in vulnerable strategic positions either because they are competing in emergent or highly competitive industries or because they are attempting pioneering technical strategies. It was also found that alliances form when firms are in strong social positions such that they are led by large, experienced, and well-connected top management teams.

[32] Similarly, these researchers acknowledge some issues as open problems of the emerging business, for example: on the competitive level, they raise the question on how will endure the USA leadership on the international market. And, specifically, on what will be the ultimate effects of a large scale transfer of technical knowledge to the industries of competing nations.

This same literature expresses the need to ensure more analysis on the conditions under which alliances are negotiated, and, on what benefits parties expect to receive, and what the perceived costs and pitfalls of such relationships may be.

[33]The research include in this category "NBFs on the basis of the primary market that the company serves. The four main market segments that NBFs are found include diagnostics, therapeutics, agriculture and instrumentation and supply. Three other very small segments- specialty chemicals, bioremediation (environmental cleanup) and animal health care – are in very early stages of development. We decided not to include NBFs in instrumentation and supply because their focus on developing research instruments, reagents, and the like makes these firms very distinctive. They are less involved in R&D, do not face costly and complex clinical trials, and do not have close ties to universities. These are companies that focus on plant genetics and the development of microbial pesticides and herbicides. In part because of public opposition and regulatory controls, research in this area is still in its infancy. The regulatory environment for ag-bio is fundamentally different from that of therapeutics and diagnostics. In the latter cases, the risks are ultimately to a single individual who chooses to take a drug or a test, and the benefits are very clear. With ag-bio, the risks are collective. There are possible harmful externalities and the benefits are less obvious. Our focus is on the most R&D intensive sectors, where NBF development has been the most pronounced. The human therapeutic market is the most research intensive segment of the industry and the one for which the greatest promise is held. Therapeutic products address a wide range of diseases and conditions involving the blood system, the immune system, and hormonal balances. These products, which provide therapeutic alternatives where

well endowed pharmaceutical companies, these firms would pursue a specialist strategy wherein they attempt to exploit a specific market segment. In this situation it is possible (or expected) that they would pursued a limited number of agreements with only those partners that contribute to this specialist approach. In other words, if NBF chose to internalize various stages of the production process and resort to external ties only when their internal capability is lacking, a transaction cost argument would contended that over time, successful NBFs would rely less and less on outside parties. Instead, in these authors' perspective, NBFs are more nearly to attempt to both develop in-house capabilities **and** promote external collaboration. External ties should be viewed as complementary; that is, one agreement would serve as a means to enhance a configuration of skills and products that a firm is developing. "In a very simple terms, imagine that firm A faces a choice of forming an agreement with partner X to pursue a research collaboration, or with partner Y to market a new diagnostic test. If agreements are viewed as substitutes for one another, than the firm would chose only one partner. The choice itself presumably would be dictated by the strategic logic of either specialization or internal integration. In contrast, if agreements are viewed as complementary, then firm A would pursue both agreements, following a strategy that suggests that the gains from one agreement might augment the gains from another" (Powell, Brantley. Op.cit. pg. 391).
On this fundamental motivation, there is the explanation of the permanence of collaboration and of the network configuration of most R&D actors in biotech field.
Here enclosed we can observe one kind of actors involved in a biotech networks (tab. 3) and a taxonomy of the type of relationship (tab. 3a) used in the above mentioned contribution of Barley, Freeman and Hybels (1992).

Table 3: Types of organizations involved in the U.S. Biotechnology Community
Dedicated biotech firm (DBF)
Diversified corporation
University
Research institute
Hospital
Government agencies
Investor
Supplier of goods
Supplier of services
State biotech center
Trade association
Repository
Potential DBF
Not otherwise classified

Source: Barley, Freeman and Hybels (1992).

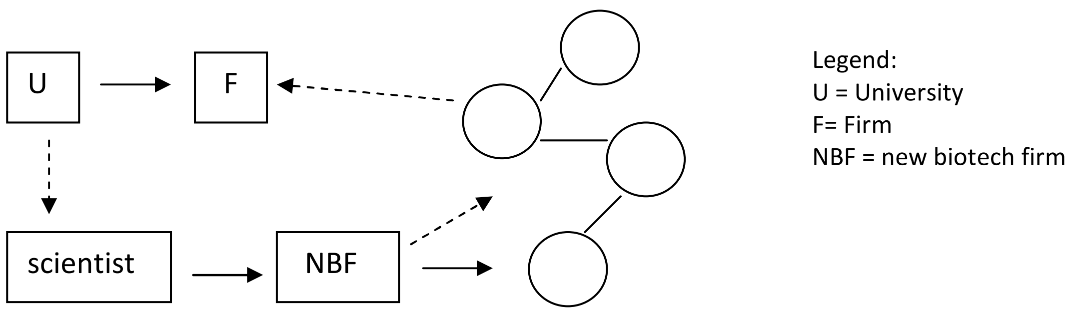
none previously existed or that are superior to existing ones, faces a lengthy and costly process of clinical trials to meet government standards for efficacy and safety. The diagnostic field consists of products used to detect diseases conditions (AIDS, cancer), physiological states (pregnancy), or genetic abnormalities. These diagnostic tests are of two types- in vivo and in vitro. In vitro tests are performed in laboratories, usually with blood samples. Because they are used outside the body, in vitro tests are not subject to stringent regulatory review. The subsequently lower costs of development have led to rapid growth in this area. In vivo diagnostics are done in the body itself and basically involve the use of imaging agents. These tests are subject to the same regulatory process as therapeutic products" (Powell, Brantley, 1992. Pg. 392).

Table 3a: Types of relationships in the U.S. Biotechnology Community
Equity holdings
Marketing agreement
Licensing agreement
Development agreement
Research agreement
Joint venture
R&D agreement
Manufacturing agreement
Grant
Supply agreement
Unspecified agreement

Source: Barley, Freeman and Hybels (1992).

The research of Powell and Brantley (1992), focused entirely on formal agreements, through some statistical description gives an insight into what kinds of firms are most likely to be involved in multiple formal arrangements. They use the Bioscan directory (an independent industrial reporting service) which lists more than 900 organizations, commercial, no profit, U.S. and international, dedicated biotech firms as well as diversified chemical and pharmaceutical corporations. Their focus is on the NBF. This firm, already known as a private lab, targeted to supply research services, are picked up only if generally independently owned and not in a stable subsidiary of a larger company.
The same authors underline the nature of research results uniquely focused on formal arrangements. They already advert the need to explore in a future research the important role of informal relations or in the relations that underlie the traffic back and forth between universities and NBFs. As first step in this direction they collect information on the science advisory boards for the firms in their sample. Where the initial interviews with scientists who are extensively involved in these consulting relationships suggest that formal agreements among universities, research institutes, and NBFs evolve out of preexisting educational and work-related ties (see figure 5 below).

Figure 5: The biotech innovation process (follows)



Source: our elaboration

These contributions, then, begins to open a fundamental debate on the definition and characteristics of the network (length, shape of ties, etc.) in this field, but also in terms of strategic priorities: if the production/value depends on the access to knowledge and this access is secured by a dense network of formal and informal nature, the critical point of attention is, no longer – or not only - a problem of "finance", but it becomes the result of a previous internal organizational (and strategic) capacity to establish and ensure access to these networks.
In particular, focusing on (biotech) research network, is, now, more difficult to pick exclusively "basic research actors" so as "applied research actors" but more probably an NBF with a multiple portfolio of research project each at a different evolutionary stage between knowledge creation and knowledge capture practices or an academic department in which different research project are encouraged and differently targeted or even large firms whose employee works in a close scientific relation with external researchers. Each one of these actors could strategically move between basic and applied research in a shared value creation process.
For each one of these actors the search for competitive advantage/value may be interpreted in terms of the search of the necessary capabilities and their external environment may be considered as an open economy with rapid innovation and globally dispersed sources of invention, innovation, and manufacturing capabilities.
At this point, the research for a better functionality of innovation process in biotechnologies move toward the exploration of a) internal organizational capacity and b) to the external network that the same organization is able to built.
The research questions is on what is, therefore, based the internal organizational capacity, and how the biotech actor/organization may built this organizational capacity.
Selecting the DCs' theoretical view to explore these issues means that "the fundamental economic problem (value creation in R&D) is solved by strategic managers" (Helfat et al., 2007. Pg. 19).
As we have seen before (par. 2.2, note 25), DCs' disciplinary foundation is economics. "What differentiates it is that it is based not on mainstream economics, but on evolutionary economics (Nelson, Winter, 1982; Winter, 2003). Evolutionary economics is a behavioral approach to economics that is focused on routines, capabilities and change. Unlike most form of economics, it attends to process issues and other phenomena deep within organizational boundaries. Even so, as an economic theory it can at best tell only a part of the full story about dynamic capabilities. The concern of dynamic capabilities with such process issues as resource allocation, change management, and other mechanisms suggests the utility of other disciplinary lenses as well. Process scholars have developed models of these processes issues that draw on behavioral theories. For example March's (1991) distinction between exploitation and exploration search can inform study of the capacity for identifying opportunities for change" (Helfat et al., 2007. Pg 35-36).

2.4.2 The derived research logic

A first step for the construction of the derived research logic is due by the selection of DCs' approach to study both basic and applied research actors operating in biotech field. Each actor will be considered and individuated, in its value capturing endowment, as composed by both a Unique Asset Base (UAB) and by Dynamic Capabilities (DCs) (see par. 2.2).
So, to operationalize these two concepts, we propose the UAB (the mix of technical equipments, professional skills and know-how) as given by the specific firm assets. We will collect also the number of formal external arrangements of each actor observed. To individuate

firm's DC (the firm's organizational abilities to purposefully create, extend or modify the UAB) we propose a previous examination of the research contributions focused on the modes of organizing biotech innovation at network level (see par. 2.4.3). As we know (Helfat, et al. 2007), DCs are context dependent. And a first conceptual yardstick for measuring the performance of DCs is "evolutionary fitness"[34]. "Evolutionary fitness refers to how well a dynamic capability enables an organization to make a living by creating, extending, or modifying its resource base. The analogue to evolutionary fitness for operational capabilities is what as come to be called "external fit". Evolutionary fitness depends on the external selection environment: evolutionarily fit dynamic capabilities enable a firm to survive and perhaps grow, and to prosper in the marketplace. Thus, the extent of evolutionary fitness depends on how well the dynamic capabilities of an organization match the context in which the organization operates" (Helfat, et al. 2007. Pg. 7).

Our research will explore four case studies. Each will be represented by a success biotech research organization located in southern Italy. Each organization will be studied for what it have already put in action to reach a success position. In the need to understand which part of the organization may represent the UAB and the DCs. By posing V as value[35]/success, we will try to interpret/operationalize for each organization the following expression:

V = UAB + DCs[36]

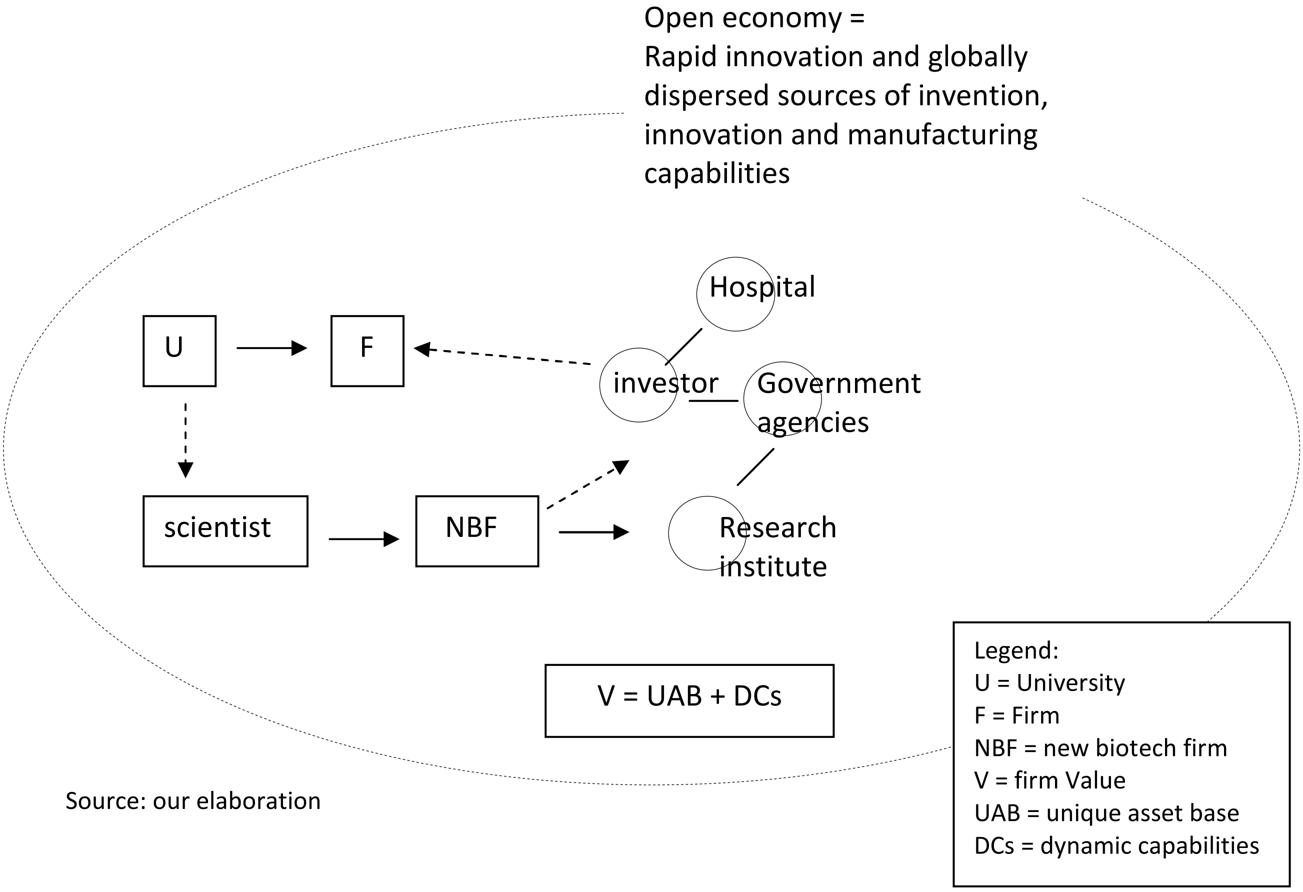
In other words, if we assume that each organization rely on a network of possible partners and that they operate in an open innovative environment, we will have to provide a framework such as the generic one illustrated in the figure 6.

[34] "The population ecology literature has used the term "fitness" with reference to the ability of an organization to survive in the face of Darwinian-like selection by the external environment (see e.g., Hannan and Freeman, 1984). Winter (2003) uses the term "ecological fitness" to incorporate the impact on organizational survival (including net reproduction or growth rates) not only of the technical fitness of an entire organization, but also the technical fitness of individual attributes (e.g., capabilities) of organizations" (Helfat et al., 2007. Pg. 7).

[35] Although we are not interested in performance measures for this analysis (as we have selected only success cases) we have to remember that in this framework an economic logic underlies the most commonly used conceptual measures of firm performance: i. e. value creation (willingness to pay minus cost), competitive advantage (relative value creation) and sustained competitive advantage. More probably a wider definition of firm value is needed when network governance and incentive issues are discussed. Here, the network value is the concept that emerges and operates as a behavioral driver. The problem may newly emerges in this research when a common organizational solution has been founded for both profit and no-profit agents.

[36] The + symbol serves to indicate the same relation of complementarity between the two groups of resources indicated by the DCs theoretical framework. We also assume these DCs as critical to the organization's performance and the absence of any causal ambiguity.

Figure 6
The generic firm environment and the generic firm value definition



Source: our elaboration

2.4.3 DCs as R&ICs for research-based BFs

Even if today it is more and more difficult to select a unique basic-research actor and/or a unique applied research actor in a biotech network, the link between the two phases of the research/innovation process remain highly critic in BF's value generation. The two processes can be related to actions rather than to a single actor and can be represented by the knowledge-creation activity and to a distinct capacity to capture new ideas or, more, to develop and implement these new ideas on a large-scale production process.

Some prior studies, conducted mainly for the USA, have focused on the modes of organizing biotech innovation by highlighting the substantial network domain (Powell, Brantley, 1992; Powell, Koput, Smith-Doerr, 1996; Powell, 1996; Powell, 1998; Kogut, 2000; Powell, White, Koput, Owen-Smith, 2005).

The structural features of networks (e.g. their density, scope, strength of ties) linking public research organizations (PROs) to commercial firms have been subjected to a good deal of analysis (Powell et al., 1996; Owen-Smith et al., 2002). In the field of biomedical innovation, for example, the critical role of relational and integrative capabilities for the entire innovation system has been described (Owen-Smith et al., 2002). It refers respectively to the ability of scientists to move back and forth between basic science and clinical development, and to the ability of organizations within an innovation system to collaborate with other diverse organizations. In keeping with "national innovation system" approaches, the research suggests that these capabilities stem from macro-level institutional differences in the structure and operation of networks and, thus, differ across nations (Carlsson, 2002; Nelson, 1993). In particular, Owen-Smith et al (2002), through an analysis of upstream R&D linkages, have demonstrated that these capabilities are better developed in the US institutional context than in Europe. This, they suggest, accounts (at least in part) for the US national advantage in biomedical innovation.

As yet, however, relatively little research has focused on identifying the ways in which such macro capabilities are recognized and applied at firm-level. Thus, whilst there is now evidence linking macro data on networks to quantitative indicators of innovation (e.g. the development of patents or the diffusion of innovations), there is also scope for qualitative research to complement this by investigating the process through which macro-level capabilities play out in the experiences of single firm and its specific value creation process. For example, how might the ability of scientists to move back and forth between basic science and product development (i.e. integrative capabilities) facilitate the value creation process in a particular BF's organizational setting?

With regard to relational capabilities, there is ample evidence that individual firms, even large pharma, do not possess all of the resources necessary to successfully develop new therapeutics (Powell et al., 1996). Individuals and firms, therefore, need to collaborate formally and informally to acquire the necessary resources. In the biotechnology sector, "open" channels have been found to be particularly helpful in facilitating opportunities for knowledge creation through the enhanced likelihood of "spillover effects": that is, knowledge is more likely to "leak" though more open channels (Owen-Smith and Powell, 2004; Murray, 2002; Kreiner and Schultz, 1993). Similarly, Salman and Saives (2005) show that, as well as being influenced by direct relationships between organizations, innovation outcomes are attributable to informal, unpredictable relationships generated through indirect ties, which create access to expertise beyond formal alliance partnerships. Other literature has emphasized the importance of trust-based, informal networks for R&D (e.g. Liebeskind et al. 1996; Kreiner and Shultz, 1993).

This prior research is indicative of the ways in which relational and integrative capabilities (R&ICs) might influence innovation processes in broad terms. For example, it suggests that one important mechanism via which integrative capabilities could influence innovation at project level is through the career identities and values of individual scientists involved in project work, in particular the extent to which they see goals of science and commerce as mutually acceptable. Similarly, relational capabilities at the macro level (as indicated in prior research by the density and scope of network ties within regions and nations) would appear to be related, at project level, to the ability of the organizations involved in innovation process to acquire and create relevant expertise, with informal networks being especially important in this respect. However, further research is needed to explore these mechanisms in detail[37].

The above serves to build our derived research logic, summarized in figure 7.

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37 The value of understanding relationships across different levels of analysis has also been observed by Gittel and Weiss (2004) who note that "frameworks for analyzing organizational phenomena must be responsive to the dynamic and complex characteristics and inter-relationships between multiple levels of analysis that "real life" situations reflect". As already seen, an important aspect of these dynamics in the case of biomedical innovation concerns the ways in which networked relations and the combination of specialist forms of knowledge and expertise are actually coordinated amongst the different parties involved in innovation projects.

Figure 7: The derived research logic

$$V = UAB + R\&ICs$$

Legend:
V = value
R&ICs = relational and integrative capabilities

Source: our elaboration

In other words, we can say that: if competitive advantage is reached when the firm/organization is endowed of both UAB and DCs, and if we consider the specific case of a research-based biotech organization (public or private), where value is generated by the effective transition from basic to applied research, than the organization itself can create value only when it is endowed of both UAB and R&ICs.
Than: the specific research question will concern the analysis of the way in which biotech research-based organizations, located in southern Italy, recognize and apply the relational and integrative capabilities (R&ICs) for value[38].

[38] We remember that the present research is addressed to explore the policy implications of a certain firm behavior. If it was addressed to explore the role of dynamic capabilities in the market competition we would have to set a measure of firm performance. In this case, we would also state that even if a dynamic capability creates high value, the firm may gain no real advantage if it creates no more value than other firms.

CHAPTER 3 – ADDITIONAL RESEARCH/ANALYTICAL TOOLS

In order to complete the set-up of research tools, it will be worth conducting a short review on informal relations and on the critical organizational dimensions involved.

If a portion of firm value is provided by R&ICs, and if these abilities may be expressed via formal and informal relations, we need to analyze these conceptual categories in greater depth so as to construct a valid encoding paradigm for empirical analysis.

With regard to formal ties, we can quite easily map the formal network emerging from the connections of the firm, such as research consortia, joint ventures, capital participation and subcontracting, that have been formally built up over a given period of time. All the formal contracts in which the firm declares to have engaged can then be collated and described, whereas additional guidelines are needed insofar as informal links are concerned.
Going beyond the pioneer work of sociologists (Granovetter, 1973) whose definitions (in this case between strong and weak ties[39]) have proved to be useful, other problems regarding the contextualization of the broad definition of informal relations for biotech organizations have to be addressed.

3.1 Informal relations

A good review of the research on this topic has been conducted by Powell and Grodal (2006). Their organizational approach and Powell's previous research dedicated specifically to biotechnologies provide the necessary reference for our analysis. We quote the authors' discussion directly with a view to adding our own contribution in subsequent sections:
"Informal patterns of affiliation have long been a central topic in sociology and anthropology, where studies of friendship networks, advice and referral networks, and communities are common. There is also a well-established strand of research in organization theory that points out how informal relations within organizations are often not closely aligned with formal authority (Dalton, 1959; Blau, 1963). A small line of work focuses on the impact of informal networks in large, multinational companies (Ghoshal, Bartlett, 1990; Hansen, 1999). Relatively

39 While there are many studies highlighting the role of formal relations on innovation (more dedicated to high-tech industries), relatively few studies link informal ties to the innovation process. Commonly cited is the work of sociologists in which informal ties are considered as an acquaintance or a friendship, or as a bond that stems from a common interest or affinity.

few studies, however, link informal ties to the innovation process, and there is scant research on informal inter-organizational relations.
Scholars have often argued that the sharing of complex information is enhanced by embedded ties, which suggests that informal ties have the potential to make a significant contribution to innovation. There is a strong sense among researchers that informal relations undergird formal ties. Powell et al (1996) argue that, in the life sciences, "beneath most formal ties lie a sea of informal ties". Nevertheless, many organizations are largely unaware of the extent to which formal activities are buttressed by informal connections (Cross, Borgatti, Parker, 2002).
One of the key studies of informal networks among firms was Von Hippel's (1987) work on the sharing of proprietary information among US steel mini-mill producers. Based on interviews with plant managers and other engineers with direct knowledge on manufacturing processes, he found that the trading of proprietary knowledge with both cooperating and rival firms was commonplace. He was initially surprised that proprietary knowledge was so "leaky", but he came to recognize that information exchange was highly reciprocal and conditioned on/by expectations that requests for help would be met. Much of the information that was shared focused on production problems, matters of pollution control and safety, and issues dealing with industry-wide concerns. But when relationships among engineers in rival firms were particularly close, more proprietary information was exchanged. Von Hippel also found that engineers had strong norms of membership in a professional community that cut across firms, and that information trading was a means to secure reputation and status in that community. He provides numerous examples of how the sharing of complex information by engineers contributed to the productivity of mini-mills.
Likewise, the cluster of individuals that share a similar set of skills and expertise has been dubbed a "community of practice" (Wenger, 1998), or a "network of practice" (Brown, Duguid, 2001). Similar in some respects to a technical community, or a sophisticated hobby club, these loose groups are engaged in related work practices, though they do not necessarily work together. Such fluid groups are important to the circulation of ideas. Saxenian (1994) observed ample sharing of proprietary knowledge among engineers in Silicon Valley, many of whom have as strong a commitment to their peers within the same occupational group as to their companies. Saxenian argues that informal knowledge sharing, widely institutionalized as a professional practice in Silicon Valley, is one of the crucial factors contributing to its fertile innovative climate. Cohen and Fields (1999) stress that professional ties in Silicon Valley are forged in complex collaborations between entrepreneurs, scientists, and associations, focused on the pursuit of innovation and its commercialization. This collaborative process generates and refines the intangible raw material of technical change-ideas.
Kreiner and Shultz (1993) analyze the importance of informal ties through in-depth interviews with university researchers and industry research directors in the Danish biotech field. They stress that successful collaborative R&D alliances within the Danish biotech industry are often based on informal ties. A barter economy, where materials, laboratory tests, chemicals, etc. are exchanged, was pervasive in this sector. They show that norms of sharing information on the frontier of research aid in the formation of more formal networks. As in the mini-mills, information exchange is not under managerial control, even though such reciprocal flows can be channeled by managerial actions.
Many studies of informal relationships stress the significance of trust. Tsai and Ghoshal (1998) studied the association between intra-firm networks and innovation in fifteen business units of a multinational electronics company. They found, not surprisingly, that social ties led to a higher degree of trustworthiness among business units, which contributed to product innovation. The

importance of trust also looms large in Uzzi's (1997) analysis of the difference between "arm's-length" ties ("a deal in which costs are everything") and embedded ties ("you become friends with these people-business friends. You trust them and their work. They're part of the family). Uzzi conducted interviews and ethnographic observations at twenty-three women's better dress firms in the New York City apparel industry. His study is notable not only for the quality of his data, but also for his attention to the performance consequences of different kinds of different relations. Uzzi found that organizational performance increases with the use of embedded ties to network partners, as these ties were superior at conveying complex, context-dependent knowledge. He argued, however, that a balance between a firm's embedded ties and a firm's arm's-length ties needed to be struck, because a network structure comprising only arm's-length ties or embedded ties decreased organizational performance" (Powell, Grodal, 2006. Pg.70-72).
We pose in table 4 the main codifications of informal relation modes emerging from the literature reviewed.

Table 4: Informal relation modes (for value, innovation): literature reviewing

Von Hippel, 1987	Professional communities
Wenger, 1998	Community of practices
Brown, Duguid, 2001	Network of practices
Powell, Grodal, 2006	Technical community; Fluid groups; Sophisticated hobby clubs
Saxenian, 1994	Informal knowledge sharing
Cohen, Fields, 1999	Professional ties
Uzzi, 1997	Embedded ties

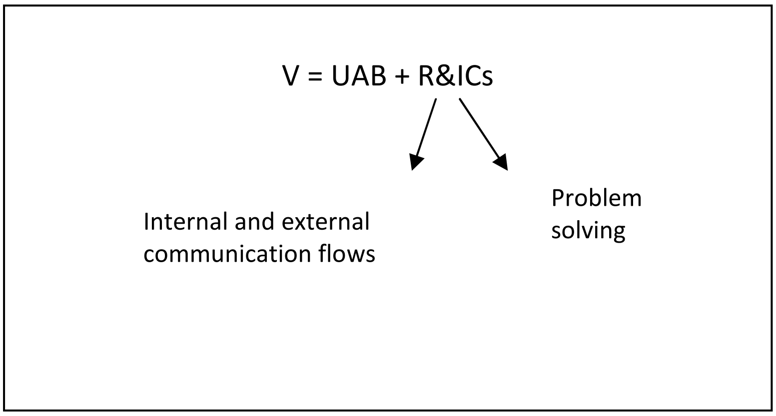
Sources: our literary review

3.2 Finding and fixing critical dimensions of potential informal networks in BFs
Returning to our derived research logic, we have, lastly, establish how to collect empirical data to interpret informal relations.
For this analytical purpose, we can refer to the recent contributions of organization analysis.
Using relational data, these research contributions have shown that the critical dimensions of "communication process" and "problem solving" (Cross, Parker, Sasson, 2003; Cross, Parker, 2004) may constitute the two basic analytical areas wherein the most important informal linkages will be found.
More, some research (Brown, Duguid, 2000; Cross, Baird, 2000; Dixon, 2000; VonKrogh et al., 2000; Cohen, Prusak, 2001; Cross, Parker, Sasson, 2003) suggests that in today's de-layered, knowledge-intensive settings, very common in biotech firms, most work of importance is heavily reliant on informal networks sitting across core work processes. These informal links weave together new product development initiatives or integrating strategic initiatives such as alliances or mergers. They enable effective collaboration and integration of different expertise necessary for innovation. While such networks are generally not found on any formal

organizational charts, we will look for a range of actions considered at the base of effective collaboration.

Finally, the complete "derived research logic" will appear as in the figure 8 below.

Figure 8: The derived research logic



Legend:
V = value
R&ICs = relational and integrative capabilities

Source: our elaboration

3.3 Firms' description, Data Collection and Data Analysis

To complete the list of analytical tools we present the empirical part of the present study.
We conducted a participant observation through direct visits over a period of two years.
Matched pairs of firms operating in the field of biotechnological research located in southern Italy were selected in a way that they could be considered to operate under similar conditions and regulatory regimes but differed considerably with regard to ownership (whether profit or no-profit mission). We consider them to be the most successful[40] cases in southern Italy.
In table 5 below, we synthetically show the four cases, marked as A, B, C and D. Cases B and C were paired since they are both non-profit organizations (a foundation and a public consortium), while cases A and D are two private organizations.
The structural dimension (see fig. 9) of B and C is very similar in that they each possess 13-15 research labs (see RL in figure 4) and 5-7 service facilities (see B in figure 9). In both cases, the Scientific Director (D) is the coordinator and founder of the center, the Staff Coordinator (SC) is responsible for daily management while the Administrative Director (C) is in charge of the center's administration. Case B, in addition, has a Scientific Office (A) that (i) assists the director

[40] Success is considered in terms of almost five years of business activity with a substantial employment growth and/or increase in the number of external partners and/or research projects.

in defining scientific strategies and policies (ii) produces key scientific documents for the center (iii) oversees the evaluation of the center and (iv) is responsible for the coordination and assembly of institutional grant applications. The unit was created because of the complex financial configuration of the center. Indeed, it covers structural and research costs with the foundation's internal resources (partly from donations), and with external international funding agencies through direct participation in funded consortia or via specific research projects. An Internal Advisory Board (IAB) comprising internal group leaders and an External Advisory Board (EAB) consisting of external experts completes the organization chart.

Table 5: Cases: a synthetic description

	Ownership	Facilities	Output
A	private owners	4 labs located in different Italian scientific poles	Customized research services
B	No profit foundation	One local unit with 20 research groups	Basic research
C	public consortium	One local unit with 13 research groups	diagnostic services and basic research
D	private owners	One research lab	Applied research

Source: our data

Cases A and D are represented by two small private biotech firms. Largely focused on research services, case A is owned by two persons (CEO and President of the company, indicated by A1 and A2 in figure94) whose interests lie essentially in the success of their firm. The structural dimension of their operation is quite straightforward and includes 4 research laboratories. The structural dimension is very simply. There are 4 research labs providing advanced custom services like Antibodies, Peptides, DNA synthesis, DNA sequencing, Protein Analysis and a variety of pharmacological services based on the use of a state-of-the-art animal facility.
Case D is a small private firm mainly focused on the discovery of new agrochemicals and new active ingredients for cosmetics applications. Technology development is focused on signal transduction pathways of plants, pathogens, pets and mammalian cell systems. The strategic combination of its scientific know-how in plant biology and the experience in drug discovery makes this company a very good partner in the identification of novel active compounds for cosmetics and agriculture.
Structural dimension is the simplest of all in that it is composed of one lab and less than 10 researcher-employees. As the youngest firm we observed (founded in 2004) it is run by three managers (two of them are the principal owners of the company). The firm uses capital participation on a broad scale, and it has, at the moment, two important partners in two large sized firms (B1 and B2 in the figure 9).

Data collection was conducted from January 2008 until December 2010 according to Yin's (1984) call for multiple sources of evidence and collected data through interviews, site visits and archival records. There were two distinct data collection phases, the first driven by exploratory

research logic (see § 1.2) and the second as per derived research logic (see § 2.4). Primary sources included site visits, direct conversations and semi-structured interviews. Our informants were the senior scientists (and founders) of the labs who were able to report on the company's development. The semi-structured questionnaire guiding our interviews included questions about the individual respondent, the company's history, organization, performance, and the nature of the company's external relationships at each step of the firm's development. During the second phase of data collection (according to the derived research logic) we observed collaboration across the hierarchy and organizational boundaries (internally between R&D sites and externally with academic scientists). Relational data were collected by means of an SNA questionnaire with few questions on communication flow and problem solving.
Following our exploratory research logic (V = UAB + R&ICs), the data was collected by extracting information on the components of the UAB (made up of technological plants, specific professional skills and know-how) through their attributes and referred data, and by adopting social network analysis, based on relational data, for the purpose of interpreting R&ICs[41].
During the final stage of data collection and validation, the informants helped us to identify more and less all of these relations and provided feedback on the data and their interpretation. We gave them brief summaries of the cases while they provided further details on case material and clarified open questions.

A synthetic scheme of our firms' UAB is given in tab. 6.

Defining how R&ICs lay down the value creation process in the organization is challenging.
With regard to the relational dimension, we identified the following important links for our cases:
1) Relations with other basic research centers. The link with academic research groups is important for both profit and non-profit research organizations. Underlying this need is knowledge integration for small private biotech labs, and access to international research networks for non-profit research organizations.
2) Customer relations. If stable and continuous, these links may be of focal concern and fundamental to a private biotech's *raison d'etre*. For non-profit organizations the customer is mainly the external evaluator of research or publishers of highly reputable scientific journals.
3) Relations with other biotech firms. They are highly developed in the case of small biotech labs and are engaged with via close and formal ties(like an interlocking board).
4) Relations with other firms. The source of the relation may be a specific project, but it may occasionally evolve into a completely new product/process. If supported by trust nurtured in

[41] An increasing number of contributions use Social Network Analysis (SNA), a set of analytical tools that can be used to map networks of relationships and provide an important means of assessing and promoting collaboration in strategically important groups (Scott, 2000; Wasserman, Faust, 1994; Carrington, Scott, Wasserman, 2005).
SNA has roots in social science research that date back to the 1930s. The idea of drawing a picture of the connections among a specified group of people is often credited to Dr J.L. Moreno (1934), an early social psychologist who envisioned mapping the entire population of New York City. Since that time, the field has grown significantly from a methodological standpoint with the advent of the personal computer and a global, multidisciplinary society of social network analysts called International Network of Social Network Analysts. Significant theoretical contributions have been made to the fields of sociology, social psychology, anthropology, epidemiology, and management studies, by virtue of the application of social network techniques. In the field of management, interest has tended to focus heavily on issues of social capital (e.g., Burt, 2000; Leenders, Gabbay, 1999; Adler, Kwon, 2002); information flow in social networks (e.g., Allen, 1977; Monge, Contractor, 2000); and the informal structure of an organization (e.g., Krackhardt, Hanson, 1993; Nohria, Eccles, 1992; Lincoln, 1982).

another job, the meeting between (biotech) scientists and producers can turn out to be full of new product ideas.

Table 6: Cases: UABs

	Labs	Employee	Know-how
A	4	30	Dna & Rna synthesis Dna sequencing Gene cloning and expression Peptide synthesis Monoclonal antibodies
B	13	115	Developmental disorders Inherited eye diseases Inborn errors of metabolism Functional genomics and systems biology
C	16	28	Molecular basis of hereditary diseases Molecular basis and therapy of leukemia Bio informatics Genetic applied to medical problems Molecular oncology and tumor genetics Neurosciences
D	1	10	Plant stem cell Plant cell biofactories Plant stem cell metabolic engineering

Source: our data

In working with the groups selected, we first obtained the formal organizational chart to see how the people were hierarchically connected. We then asked each person within the group who they relied on for information to get their work done.
On this particular point we investigated R&ICs by asking the following questions:
1) Who (individual or group) is able to relate with external (effective or potential) partners?
2) Who (individual or group) is able to integrate new information and knowledge from outside into the organization?
From our survey responses to these two questions we produced social network diagrams showing the map of effective connections amongst the people in the organization (see fig. 9). A specific node of the network may be considered "critical" if it serves as a broker for information (Burt, 1992). These nodes, which contribute to reaching external research groups, are considered essential for the accumulation of dynamic capabilities. They are recognized for their central position in the network (i.e. by the high number of connections they have). Likewise, in these kinds of organizations the internal structure is focused on technology, and the distance (or physical separation) between the labs may be bridged with informal meetings. It is also possible that the critical role played by these meetings will be determined by mid-level/middle managers with more structured means.

A synthetic scheme of our firms' formal relations is given in tab. 7.

Table 7: Cases: Formal relations (number)

	Other Italian research centers	Other biotech firms	Other firms	Public funding agencies	University and CNR	Public Institutions
A	2	1	1			
B	2			14	5	
C	2				1	1
D			2			

Source: our data

Data Analysis was firstly conducted to explore which part of the organization was more involved in value creation. For example, case A showed strong customer care orientation and value depends on the ability to interact daily with customers. In addition, for firm A the customer is, at the same time, the principal knowledge supplier represented in the main by academic research groups. Thus, it is important in this context to find who (individual or group) interact more frequently with these external groups. Of course, this first phase also analyzes the static component of firm value (UAB) for each case.

We subsequently expanded our case description by adding the relational data and specifically configuring the relationships both inside and outside the firm. The completed case study was finally re-proposed in terms of process-position-path[42]. We then compared value solution in terms of UAB and dynamic capabilities. Interestingly, at the organizational level there is convergence on the social entrepreneurship nature of dynamic capabilities.

[42] This is a possible way to describe a firm's value configuration using the DC approach. In particular, the model refers to the managerial and organizational PROCESS for what might be referred to / addressing a firm's routine or patterns of current practice and learning. By POSITION is meant a firm's current specific endowments of technology, intellectual property, complementary assets, customer base, and its external relations with suppliers and complementors. The term PATHS refers to strategic alternatives available to the firm, and the presence or absence of increasing returns and attendant path dependencies.

CHAPTER 4 - FINDINGS

The following notes will argument the evidences and some logical implications emerging from the research path. The notes will be grouped in three key-issues connected to the structural configuration of the firms' organizational settings, to the value solutions expressed in terms of process-position-path, and to a final implication on regard of governance and incentive issues.
A final discussion will be given about the main concordance and/or differences between our observation and the theoretical model.

A. Configuration of BFs' relational and integrative capabilities and value implications

We identified two different structures in the firms' organizational settings (see figure 9). A quite simple formal setting corresponding to the institution's dominant rules (indicated in figure 9 by unbroken lines), and the informal network arising from communication flow (indicated in the same picture with dotted lines), centered mostly on few critical nodes[43].
We start from a declarative setting to observe the dominant structural dimension. Basically, the non-profit organizations appear to be organized in different research groups-labs guided by a principal investigator whose focus is on their specific research activity. Management functions are distributed among few top divisions devoted to administration and coordination. The few tenured positions are occupied by technicians/technical staff, while research groups are made up of PhD students or University fellows. The private organizations are similarly based on groups directed by a research leader, are smaller than the no-profit organizations and almost all researchers occupy stable contractual positions.
In all cases, the different informal structure of the organization bears witness to the importance of information and communication flow for these firms.
When viewing the picture, it becomes evident that R&ICs are concentrated in few critical nodes. Clearly, their position is central in the firm's value creation process. Any strategic activity with external actors is mainly performed by top managers. Even the role of integrating information internally is played by few central connectors, sometimes positioned at middle

[43] Organizational theorists have already given ample consideration to the difference between declarative (formal) and effective (informal) setting where an appropriate connectivity can have a substantial impact on performance, learning and innovation (Krackhardt, Hanson, 1993; Tsai, Ghoshal, 1998; Hansen, 1999; Cross, Borgatti, Parker, 2002; Cross, Prusak, 2002). Benefits also accrue from well-connected networks between organizations (Uzzi, 1996; Gulati, 1995). More recently, other research works suggest a comprehensive application of network analysis to the work of managers and leaders (Cross, Parker, 2004). In this respect, "making invisible work visible" may help mangers build and improve networks in their organizations.

level in the hierarchy. Especially in case A, value is guaranteed by the role (in terms of relational abilities) of node A1, A2 and by node 4 (in terms of integrative ability). Node A1 (the company's CEO) is informally linked to the University (on account of his personal previous experience), while node A2 (the President of the company) is in formally linked to some external actors (as vice-president of the local biotech professional association and as CEO of another biotech firm. This position is already known as a board interlock). Inside, the nodes showing the highest number of links are signaled by the numbers 2, 2, 3 and 4 (corresponding ties). Thus, while external relations are guaranteed by A1 and A2 nodes, the integration of information and knowledge inside the firm is guaranteed by nodes 2, 2, 3 and 4. The integrative capabilities are expressed in particular by the chief administrator (4) and by a researcher (3) who is very active in networking.

In case B, the scientific officer (A) is a critical connector and so too is a group (indicated by the dotted circle in the figure and often represented by the so-called Data Clubs). Undoubtedly, a strategic role is also played by the scientific director (D) who, in wishing to maintain his high scientific reputation, fosters important external relations with the international scientific community. We omitted to draw the personal scientific community of which everyone is widely endowed.

In case C, all the relational activity is concentrated in node D (scientific director). Owing to the high concentration of power in this figure, this research network may be considered substantially weak. Since the Center also operates as an incubator of new small science-based firms, it plays an important role in local development.

Case D is a small firm gemmed from incubator activity, a spin-off of case C. It started its operations in 2004 inside the incubator and since 2007 it has an autonomous location and a considerable range of partners. The basic business model consists in the strategic combination of its scientific know-how in molecular biology and cell biology with the know-how in chemistry and agronomy of its industrial partners. The identification of new lead compounds (these serve to develop diagnostic systems for specific needs) emerge from this kind of relationship. Its small, simple, horizontal and flexible organization revolves around the central figure of the firm's founder and CEO who may be considered a star scientist[44] for the entrepreneurial value she has given to the group's significant new discoveries. Most of the partnerships from which her new ideas arise, stem from her ability in social entrepreneurship[45].

Downstream of these observations, the logic of research followed, and, remember, a collection of relational data, based on problem solving and communication process (see par. 3.2), we can argue that: without individuals valuable informal relations, these firms would be unable to acquire, recombine and release resource useful to (i) create and maintain productive customer relations, (ii) to have access into international research networks, (iii) to promote occasional meetings with potential "lateral thinkers". Moreover, weak ties (or the simply periodical Data

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[44] "Until recently, economists and sociologists studying science and technology have been averse to viewing scientists as pursuing private motives, viewing them instead as disinterested contributors to a shared common pool of knowledge. Our results suggest that star scientists often are better viewed as entrepreneurial individuals who value both financial rewards and the pleasure, recognition, and resources that come from being the first to make a significant new discovery" (Zucker, Darby, 2007. NBER web pages).

45 We refer to her ability to promote occasions/situations wherein different (scientific and technical) skills may meet. And, in general, to her ability to foster social relations. A related work concerning the social entrepreneurship enforcing DCs, may be Persico, Vittoria (2010).

Clubs) facilitate internal knowledge diffusion and the continuous upgrading of "what we know" in the organizations.
Other elements such as formal organic networks, firm technical equipments, high-skilled human resources are also required. These elements may be considered in a close complementarity with informal relations.

> *Proposition 1: In biotech research-based organizations, the informal relations are strictly complementary with firm's specific and difficult-to-trade resource endowments for value creation.*

<u>B. Evidence in terms of process-position-path and convergence solutions</u>

If informal relations enable the firm to fill the internal information gaps or to gain more occasions of capturing external knowledge, the question become: are informal relations also easy to acquire?
Or, how easy is to have an access in an informal scientific community? And, who is the critical partner of an informal relation in these contexts?
In collecting our observations in terms of process-position-path (see tab. 8), we try to reach a more extensive comprehension of the mode of acquisition of informal relations.
According to the DC theoretical view, the term "process" means "to refer to the way things are done in the firm, or what it may be referred to as its routines or patterns of current practices and learning" (Teece at al., 1997. pg. 518). On this level, our cases – viewed as informational networks – may be considered polarized groups in which the main managerial practices are governed by few critical nodes (top mangers, Scientific Directors etc.). Looking at learning needs, which are partly solved in our organizations by the selection of personnel, we found a close resemblance (or integration with) to the Human Resources (HR) management practices of the public university system. Indeed, with few exceptions, research groups are made up of post-graduates pursuing an academic career.
Of course, this closeness is more evident when we look at non-profit research centers, while for private enterprises the process is necessarily different. In the latter, we find visiting researchers or scientists attending a firm's laboratory on an informal basis. In both profit and no-profit situations the learning need is addressed via relational investment, quite often based on the high scientific reputation of the people involved. Because of the information and knowledge dominion in these fields, people may interact more directly with those they already know and trust. One possible problem, for these firms, is to find "who knows what they need". It may happen only after the organization has "known what it knows". All processes requiring a kind of "reputation management" consist in helping employees develop an awareness of and trust in their partners' expertise throughout the network. Here we find "implicit" reputation management with a concentration of power (in terms of information and frequency of connections) in few critical nodes.
With the term "position", the DCs theoretical view means to "refer to a firm's current specific endowments of technology , intellectual property, complementary assets, customer base, and its external relations with suppliers and complementors" (Teece at al., 1997. pg. 518).
In the firms we observed, there is evidence of an important endowment of technologies and knowledge. Cases A and D, for instance are provided with, *inter alia,* an indispensable customer base.

Table8: Evidence in terms of process-position-path & common solution for R&ICs

	A	B	C	D	Basic tool for R&ICs
Process	Central connectors	Central connectors	Scientific Director	Star Scientist	High scientific reputation
Position	Membership in local Biotech Community; informal relations with academic groups	Membership in international Research Networks; internal data clubs	Close links to Institutions	Promoting occasional and serendipitous meetings with other experts	High scientific reputation
Path	Since its foundation (1991) from a small group of researchers, the firm achieved success as one of the most attending research partner of academic groups. Two highly skilled scientists/managers and founders are the critical node for external relations. Integration of information internally is due to a few critical nodes in the figure of some older employees.	Founded in 1994, this international reference centre was created by one of the major national non-profit organizations. The Scientific Director is the central connector with international research networks. There are some internal critical nodes (Scientific Office) for the integration of information and groups (data clubs) created to guarantee and maintain access to international research groups.	Founded in 1983, this non-profit consortium deals with advanced biotechnologies and their possible applications. The Scientific Director is the central and isolated node for internal management and research coordination. There are some successful initiatives whose aim is to extend and spread the scientific reputation of the centre.		High scientific reputation

Source: our elaboration

External relations are numerous and differ in type. The non-profit organizations are in stable, formal relationships with the Scientific and Technology Parks that host them. They have many formal links with international funding agencies through different projects. Almost all the researchers belong to a wide, informal, scientific community. The private cases (A and D) have a multiple external network, both formal and informal. For example, case A is characterized by two board interlocks in the simultaneous presence of A2 (the company president) on the board of another biotech firm in addition to that of the local biotech Professional Association. Conversely, case D is characterized by direct participation in the capital of two companies.
The term "path" in the DCs theoretical view means to refer to whatever concerns the history of the firm that, in different ways, defines its strategic alternatives as well as ensuring the presence or absence of increasing returns and attendant path dependencies.
Biotechnological environment is characterized by the rapidity with which new scientific breakthroughs are being made, and this context contributes to defining a strong path dependency for both organizations surveyed.
If we look at the case histories of A and B, we find a growing investment activity in new research groups and in new lines of research/services. What does the strategic approach to such choices guarantee? With an almost fixed core in technology and plant, how easy is it to transform or reconfigure a group of research onto new themes?
With regard to these problems, strong evidence is provided by the direct/formal participation of firm A on the board of another biotech firm (board interlock) or in the board of the local biotech association. In case B, there is the external network (formal and informal) comprising different research projects. Since its creation, the Centre has progressively moved from focusing principally on the identification of genes responsible for genetic diseases to the study of gene function and disease mechanisms. It is now making a significant move towards clinical applications. A critical node in this process is represented by its funding strategy.
In both these two cases a common solution is in the possibility to have an access to funding agencies. At the base of this possibility there is the high scientific reputation of both the company president (node A2) and of scientific director (node D).

In sum, while informal relations play a central role in helping BFs to acquire and integrate key resources (knowledge and information) for value creation, scientific reputation is the pass-partout or the key of their appropriation.

> *Proposition 2: The informal relations underlying BFs' value creation are acquired only if supported by a high scientific reputation of both relational partners*

In addition, considering scientific reputation and informal relations as intangible assets to recognize and address to reach firm's value, we can argue another conclusion, as follows:

> *Proposition 2a: under a network domain, strategic process would itself move toward an in-depth consideration of intangible assets.*

More precisely, in case study A the value creation process may be considered the result of a kind of learning-by-time process. Starting from a unique asset base (UAB) of the firm, mainly expressed in DNA sequencing competencies, it moves progressively towards a more and more customized research service. In this process, the customer relation, mainly informal and frequent, is the critical replication dimension.

In this relation, in which the customer is often represented by academic research groups, converges the main part of knowledge flow and key processes and firm routines. Here, a high degree of reputation may support these informal relations and knowledge flow.

In case study B, on the other hand, the value creation process may be viewed as the result of a kind of stay-at-the-forefront research process. It starts from a UAB of the firm, mainly expressed in the identification of genes responsible for genetic diseases, and moves progressively towards a more applied kind of research. In this process, integrative and relational capabilities (I&RCs) are represented by specific internal figures (Chief Scientific Officer) and groups (so called Data Clubs for achieving research complementarities) and also by the participation in prestigious international research networks. In this processes, the recurrent critical resource is reputation and it lies at the base of a firm's R&ICs.

For case study C, the initial technical and professional endowment is associated with its own capital structure. It is a consortium, naturally linked with local and national institutions and, as such, access to public finance is in this way guaranteed. R&ICs converged in the figure of Scientific Director, a scientist-entrepreneur with a high scientific reputation.

The value creation process in case study D started out from the personal (scientific and entrepreneurial) ability of the founder who maintains external strategic links by herself, and there is evidence of increasing expansion of different partnerships in the course of the firm's evolution. Inside, she promotes a flexible and horizontal organization in a successful and dynamic experience/way.

To close, we draw on two basic strands of evidence. First, we notice there is a specific link between reputation and dynamic capabilities in a research-based biotech firm. Second, if DCs rely on reputation both in profit and no-profit contexts, this would be linked to a strategic/convenience issue; despite the classical cost accounting approach, the strategic process would itself move toward an in-depth consideration of intangible assets.

C. Basic vs applied research network: governance and incentive issues

Can we add something to the discussion presented in section 3.1. with regard to the expected evolution of governance and incentive researches advanced by Powell and Grodal (2006)?

Substantially, the authors maintain the importance of interpreting dynamic aspects of relationships. "Initially, the choice by a young firm of whom to partner with is often driven by resource needs. As both firms and network mature, various dyadic choices increasingly reflect structural properties of the network" (Powell, Grodal, op. cit. pg 77). From our research and observation of the cases, the influence of research behavior on network structure may be confirmed. Or, rather, the network structure, mainly polarized amongst few critical connectors, explains the dominant management model of these firms, and makes us talk of the importance of reputation management as a convergent solution for our cases.

In this convergence solution we may briefly reflect on governance and incentive problems of scientific knowledge as economic assets.

Scientific knowledge has always raised problems of estimating its economic value.

"Knowledge is put to use and uses confer value. ….One of the chief functions of economies is to promote standard instruments of exchange, and when we say that an article published in Nature costs $ 2.50 for the reader to reproduce, then we have, indeed, said something about value, but not anything important or discriminating about value" (Bozeman, 2007. pg. 130).

Thus, what is the convenience of investing in some sort of relationship in exchange for scientific knowledge?
In short, It is a network convenience. Here, the value concept of scientific knowledge is in the measure of the reciprocity for all the participants.
Among the doctrinal approaches, that of Powell and Grodal stresses the organizational dimension by exploring the costs and opportunity of alliances investments. For example, the extent to which one considers it to be convenient to maintain a kind of partnership. There may be costs associated with managing a partnership or terminating it, or problems of stagnation that occur in some long-term associations.
For wider contexts, in which public and private actors are involved, as in an extended biotech research network, it may become a governance problem. Where, as we have seen in our case study research, some social aspects, such as trust and reputation, can play a more efficient role than money.
Another appropriate framework may be provided by a cooperation theory that includes the *we-rationality* or, in other words, a theory based on selection criteria centered on "sociality" and "relationality" in a non-individualistic perspective.
Along this path may be positioned the analytical proposal of Bacharach (1993; 1999; 2000; 2006) and Sungden (1993; 2000; 2003), on the border between economics and philosophy.
Their idea lies in a new conception of rationality founded not on individual interest but on a collective convenience. Based on the fundamental criticism of the game theory (widely known through the example of "prisoner dilemma"), the we-rationality framework discusses the decision to cooperate according to a rationality based on the "we". In pursuing this framework, the doctrine reaches the point of discussion concerning incentives.
On this specific topic, interesting implications are drawn by Frey (1997) when, introducing the *motivation crowding out effect*, he says that incentives, particularly monetary rewards, have a damaging effect on intrinsic motivation[46] , and then on performance.
Other opinions (Smerilli, 2006) explain the crowding out effect through we-reasoning and not with intrinsic motivation. In other words, motivation may be explained through "membership in a community" or "identification with a group". Here the presence of incentives or sanctions highlights the competitive frame and, consequently, decreases cooperation.

Conclusion

In selecting four success cases operating in the biotech research system located in southern Italy, we decided to focus directly to their organizational/governance solutions in value creating process.
This means that general research question , "how to address basic research supply in southern Italy", if translated in terms of the DCs theoretical view and applied at firm-level, has become "how southern Italy BFs recognized and apply R&I capabilities for value". In other words, the places where basic and applied research meet, now become a "critical zone" for value creation.
This still means to assume the coincidence between theoretical and operational value conditions.
In effect from what is apparent from direct observation of cases, the critical areas which link basic and applied research (or: the firm observed with University, customer, occasional and

46 Following Deci (1975), Frey defines an "intrinsic motivated" person, who is able to conduct an action when he doesn't receive any rewards, except the activity itself.

fruitful “lateral thinkers”, scientific communities, etc.) are composed of a constellation of informal relations. These kind of relations concur with other resources in value creation (see proposition 1 and a synthetic summary in the table 9).

Table 9: Cases: Informal relations

- maintain a constant link with some academic groups…through frequent and reciprocal informal visits (case A, B, D)
- maintain a stable and effective customer relation….through a daily communication flow (phone, e-mail, etc.) (case A)
- create internal structures for professional learning…internal professional figures as bridging nodes (case A, B)
- create occasional meetings with production experts of different sectors… capacity relating to the social capital of specific individuals (case D)

Source: our elaboration

The access to this kind of relation is made possible by the high scientific reputation of both partners (see proposition 2).
The inclusion of reputation and informal relations in the category of firm’s intangible assets contribute to enlarge strategic process to other possible tools (see proposition 2a).
The present research confirm relational investment as a kind of firm’s dynamic capability in this contexts. It stresses the importance, among the various relational links, of informal relations and underline the crucial role of reputation.
In other words, we can accept largely the theoretical implication on the critical role of organizational variable in capturing competitive advantages for biotechnological research-based organizations. While we put in evidence the need of an integration of the same model on regard of the deeply organizational analysis. Finally, on regard of governance and incentive problems, more researches are needed to establish the point of convenience between formal and informal safeguards to govern intellectual property.
While ever more evidences have underscored high levels of effectiveness of informal safeguards (trust, reputation) in controlling opportunistic behavior in alliance relationships (see Dyer, 1996; Gulati 1995), the pursuit of relational rents is a primary motive for building relationships.

CONCLUDING REMARKS AND FUTURE RESEARCH AGENDA

This work has addressed the question of finding solutions, in terms of strategic management, to the issue of harmonization between basic and applied research in the field of biotechnologies. The problem has been explored by adopting a case study approach on organizations selected from the biotechnology sector in southern Italy.

For these organizations, the present research shows the importance of relational investment, also on an informal base. These informal relations can assist in the selection of the right partner/interlocutor in the complex dynamic between basic and applied research.
The present research has codified informal relations for BFs in the following forms:

- Community or network practices;
- Bridging structural holes or connecting different functions (via different communicative means as well as the action of boundary-spanners);
- Meeting "lateral thinkers" (facilitating occasional meetings with production experts).

At the same time, we recognized reputation as an intangible asset insofar as it may regulate (in terms of engaging, maintaining or ending) an informal network.

We summarize the research structure as follows:

In accordance with qualitative research methods, we started from a broad definition of the research **target** (see Fig. 1). Only after our first contact with some successful organizations (our initial case studies) and an in-depth investigation of the theory were we able to focus better on the research questions (to see in Fig. 2).

Thereafter, the research process embraced the DCs theoretical framework as a guideline for exploring and discussing the empirical evidence, whereas the **derived research logic** has been formulated in the following statements:

1. research-based biotech organizations may be seen as acting in a fast-moving business environment;
2. in this context, two macro-level capabilities called Relational and Integrative capabilities (R&ICs) are recognized as critical,.
3. firm value is provided by two, static and dynamic, basic resource endowment components;
4. the static component is the Unique Asset Base (UAB) of the firm, and the dynamic component, expressed by the doctrine as DCs, has been interpreted in terms of R&ICs.

5. in our case studies, firm value has been interpreted as the sum of these two basic components.
6. if the organization recognizes and applies these two components for value creation, it means that it has found the right strategic prescription, in other words harmonization between basic and applied research.

The methodological steps together with theoretical upgrading are described in chapters 2 and 3.
Briefly, we would like to underline that one of the major critical points in this regard consists in the identification of DCs at firm-level. As these abilities are in a continuous state of flux and in fast-moving environments, it is important to try to anticipate, as far as possible, the most important external constraints and monitor their permanence/absence in the period examined. Indeed, in the biotechnology sector and the southern Italian institutional context they may change. Undoubtedly, knowledge diffusion in the biotechnology field is associated with the relational need. If incoming, external information is acquired, then an integrative need, to include new knowledge in the organization, emerges. In this dynamic, informal linkages are very important, and for this reason we felt it was important to use a method of observation based on both attribute and relational data.

The **evidence** gathered converges on the following issues:

A. Configuration of BFs' relational and integrative capabilities and value implications. What emerges in this issue is a polarized network configuration described as numerous informal links aggregated around critical nodes for value creation.

B. Evidence in terms of process-position-path and convergence solutions. Each case, observed in its strategic tension in seeking competitive advantage, may be described in terms of process-position-path. What emerges is a common organizational solution in terms of reputation management for all the cases we investigated. Intangible assets underpinning the strategic process in BFs. In terms of the strategic process it is important to consider the intangible assets, such as the social dimension at the base of an increasing number of procedures, and equally important for them to be "measured" and, if necessary, acquired and correctly managed.

C. Basic vs applied research network: governance and incentive issues**.** Network dominion governance and incentive issues may be treated in a we-rationality framework, in which incentives based on intrinsic motivation, such as trust and informal affiliation, are more effective.

In short, our findings suggest that the use of boundary-spanning social networks by the four biotech firms we observed increases both their learning and their flexibility in ways that would not be possible within a self-contained hierarchical organization. In this environment reputation is a key-management tool to know and use and, as such, it may be considered an intangible asset for the strategic process.

To relate these findings in the whole research process, we can say that our research:

a. accepts the theoretical implications of the DCs model (in the critical role of organization variable in capturing competitive advantages) for biotechnological research-based firms;
b. proposes the integration in the same model of additional analytical tools for organizational analysis;
c. highlights the need to extend to other theoretical approach the analysis of the incentives to conduct in the field of network governance.
d. Finally, with respect to the general research target and, specifically, to the expected role of the state, our research may suggest a “basic and applied research model” in the biotech field, substantially based on “actions” and no more on “actors”. In other words, in order to provide efficient and effective support to the relationship between basic and applied research in the field of biotechnologies, it will be necessary to sustain the creation of conducive environments for selecting "social value" (or to create and capture new knowledge) and, therefore, collaboration.

Future research steps may seek to advance the dynamic capabilities perspective on the value creation process. Accordingly, we will try to test the role of formal and informal relations in accelerating the knowledge and information diffusion on a wider sample of cases.

We propose that knowledge derived from informal relations (codified in the categories shown in fig. 3b) increases the likelihood of new innovative opportunities while stable, formal connections ensure the organization maintains the support of reputation. We also intend to argue that the extent to which the strategic process opens up to intangible assets or focuses on budget costs will positively influence the sustainable growth of a firm.

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