FINANCING INNOVATION IN BIO-PHARMA: A SECTORAL SYSTEMS APPROACH

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FINANCING INNOVATION IN BIO-PHARMA: A SECTORAL SYSTEMS APPROACH

A thesis submitted to the University of Manchester for the degree of Doctor of Philosophy in the Faculty of Humanities

2014

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MANCHESTER BUSINESS SCHOOL
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ABSTRACT

The literature on the financing of innovative projects follows two trends: one contemplates that either the prospective fundees or the potential funders use their preferences to choose the other party out of a range of theoretical possibilities; the other refers to project owners or investors that actively look for an “opportunity” and try to talk the other party into entering the funding relationship. These views, however, cannot explain several facts such as: why projects rejected by some funders are accepted by others, why IPOs and markets are not attractive to all players or why that changes over time and across settings, how can State funds support a sector across regions, or how players’ and setting features and time affect funding criteria.

A critique of these explanations sees three main shortcomings: lack of balance (i.e., one party’s initiative prevails), bias (i.e., criteria of the domineering party prevail), and disembeddedness (i.e., milieu factors and changes over time are ignored). We think that an analysis supported by a sectoral approach may contribute to build a more articulate, integral insight about the funding of innovation.

The bio-pharmaceutical sector was chosen because it exhibits amazing complexity related to the heterogeneity embodied by a multifaceted network of players (e.g., universities, companies, potential financiers, regulation bodies), to the nature and development path of innovative projects, and to the competitive/collaborative interactions framed in a particular setting. Hence, a qualitative approach based on the case study of the sector is the choice for this study. Case data are collected through semi-structured interviews with thirty participants that have played different roles in organisations of the bio-pharmaceutical sector or are highly experienced VC practitioners.

Our findings allow us to propose an enhanced characterisation of innovation financing by showing that: i) Investors’ understanding of a sector is essential for funding decisions and can be updated through networking; ii) Networks facilitate firms-funders contact, coordination among funders, enhancement of financiers’ knowledge about the sector, and venture owners’ knowledge of track record and potential benefits of investors; iii) Interactions involve other actors in different roles and support network-based learning; iv) Funding decisions are impacted by the geographic availability of sources/mechanisms of finance and by their readiness to fund specific venture stages; v) Investors’ specificities matter; vi) Trends of change impact the availability of funding sources/mechanisms since they imply a re-organisation of the relations and interactions among players in the sector.

Therefore, we propose a systemic analytic explanation where the strategy of funders (generalist or dedicated), therefore their role in a particular setting, is essentially defined in relation to the structure and dynamics of their knowledge consolidation system; then, we derive a number of implications for firm managers, investors, and policy-makers. Finally, the main limitations of this work and some further questions for future research are stated.
DECLARATION

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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“In a word, aside from pure physical reflexes, human behaviour cannot be understood without the concept of volition – the unpredictable capacity to change our minds up to the very last moment.”

The Worldly Philosophers, Robert Heilbroner (2000)
1. INTRODUCTION

1.1 Justification

Innovation and resource allocation are strategic activities in any company. Companies innovate (create new services and goods to be used or sold) in order to improve or strengthen their competitive position. Innovation strategy is, therefore, a component of competitive strategy. This implies that any activity whatsoever related to creating innovation, namely how to do it and including how to fund it, involves strategic decision-making on the side of the company management.

Some strategy and innovation scholars have proposed the existence, at least ideally, of a virtuous cycle by which companies develop and use or sell new services and goods to gain a better position over their competitors (equivalent to a relatively dominant market position ultimately represented by a bigger market share and higher profit), whereby additional profit achieved can be either devolved to company owners or dedicated to boost new research and development processes (the usual term used in the literature to refer to innovation) that will, in turn, generate newer services and goods (e.g., Scherer, 2001).

Such a virtuous cycle seems a straightforward manner to put money and knowledge together. Even more, these ideas seem pretty much in line with the existing ideas on how to finance the activities of a company as shall be seen in what follows. However, it can be affirmed that there is a “blind zone” in most innovation studies that is essentially tantamount to the neglect of finance in the contemporary economics of innovation. In fact, even though Schumpeter himself –in his two theoretical stages– and, later, Perez (2002 and 2004) included resource allocation and the role of finance providers in their considerations on innovation, “hardly any attention has been devoted to the relationship between innovation and resource allocation...” (O’Sullivan, 2005: p 245) let alone in strategic terms. This is self-evident as only a few studies exist that regard the particular phenomena related to the funding of innovation (e.g., Freeman and Soete, 1997; Fransman, 2004; Pisano,
Putting money and knowledge together should not seem like a big problem in the framework of a capitalist economy since innovation appears to be a predominant topic when growth, development and competitiveness are discussed worldwide nowadays. However, as most experts and players (academics, entrepreneurs, policy-makers, managers, funders) recognise, it is not easy to find enough money (sourced by the governments or by private investors) to fund all the ideas and projects that science-backed people come up with.

Moreover, even in the case of industries that have a well-established reputation in terms of success and, therefore, of past efficacious financing options, it proves difficult to keep long-run funding up to cope with the many types and stages of ideas and projects that come to the mind of entrepreneurial inventors and innovators. And, clearly, it makes no sense for any player to fund a few projects for a limited span of time and then desert the space to fund a completely different sector unless the initial projects have utterly failed and no promise of future success can be made. This is a particularly concerning aspect of financing innovation in the bio-pharmaceutical sector, for instance.

Even though bio-pharma has proved to be a key and mature sector with more than one hundred and fifty years development that has gone through different phases and has seen many enterprises of different sizes and ages consolidate, even today it is common to see entrepreneurs and companies struggle to get adequate funding for their innovative ventures. In fact, a growing concern in the industry today has to do with the scarcity of funding for early stage projects (though late stage ventures seem highly favoured) (Hellmann and Puri, 2000; Rosiello and Parris, 2009; UnicornBiologics, 2010; Haslam et al., 2011; Hopkins et al., 2013) and its potential effects over the sector pipeline state in the medium term since sectors where competition is substantially based on innovation, such as bio-pharma, might experience a huge downturn that would potentially mean not only less products (therapies) and players (e.g., companies, entrepreneurs, managers), but also a
shrinking interaction among them which might corrode the intangible asset base further (Haslam et al., 2011: p. 5). Before deciding what to do in order to avoid such dangers, a kind of understanding is required that goes beyond the theoretical prescriptive views as to take into account a more sensible and complex perspective tied to the facts of reality.

Most explanations about the financing of innovation so far (pecking order based on Myers and Majluf’s (1984) ideas, passive search grounded on Chan (1983) and Eckhardt et al.’s (2006) views, catalysing strategies postulated by Hallen and Eisenhardt (2012), and active search built upon Bygrave and Timmons (1992), Gompers and Lerner (1998) and Eckhardt et al.’s (2006) results) miss the strategic complexity involved in the existence of at least two sides (innovators and funders) that interact through competition and collaboration in different and changing settings (economies) whose conditions change over time. Furthermore, the strategic complexity based on the interdependence of multiple players, beyond fund seekers and investors, with their own motives, expectations, characteristics, and goals, cannot be accounted for by partial views that do not consider the dynamics of particular sectors whose changes may mean a complete reversal of reality factors and trends and even the appearance of massive conceptual chasms that may steer a sector in a radically different direction. Such are the background elements that impend on the apparently simple attempt to put money and knowledge together in a system where money and knowledge are supposed to be central elements of the economic activity and the boosting of material progress and well-being.

That being said, it is not startling that such theories cannot explain some common facts such as the rejection of certain projects by some investors and, contrastingly, their subsequent acceptance by some other funders or the differences in terms of IPO and specialised public market attractiveness and success within a single sector and a single economy or their mutations in such settings over time. Furthermore, no present theory can satisfactorily elucidate the reasons for the prevalence of a particular side’s criteria (investors or venture owners’) in the allocation of external funds or how such criteria can be adjusted over time and can be impacted by the other party. These and other issues beg for a systematic explanation that takes into account the complexities mentioned and facilitates analysis and decision-making processes.
1.2 Objectives

The main objectives of this research are:

- To understand the reasons and the processes that lead innovative project owners (established SMEs/startups) and potential financiers in the bio-pharmaceutical sector to establish contact and interact in order to make strategic funding decisions;

- To unveil the specificities of the interactions and decisions in the bio-pharmaceutical sector in what concerns established SMEs/start-ups and financiers mainly;

- To understand the manner in which a sector’s (bio-pharmaceutical) contextual characteristics influence the interactions and strategic decisions of project owners (SMEs) and potential financiers;

- To reveal the principal implications of using specific sources and strategies to finance SMEs/start-ups’ innovative projects in the bio-pharmaceutical industry.

1.3 Methodology

This study adopts a qualitative approach based on the case study of the bio-pharmaceutical sector. Bio-pharma was selected as the appropriate sector for the case study due to the particular characteristics of innovation in a science-based industry (typically fundamental uncertainty, extremely high risk, continuously growing information gaps, high intangibility and specificity of assets, relatively longer time horizons, strong role of innovators) and the specificities that such traits involve regarding the financing of bio-pharma ventures (O’Brien, 2003; McKelvey et al., 2004; Rosiello and Parris, 2009; UnicornBiologics, 2010; Haslam et al., 2011).

Primary data collection was done through elite semi-structured interviews (audio recorded) with thirty participants selected on the basis of a set of criteria (more in Chapter 3). The statements collected during the interviews were transcribed and deconstructed into blocks of data about seven main issues; it was then processed by means of thematic analysis and ordered into a matrix display that, in turn, provides
the elements necessary to re-create a narrative around the main issues identified. Finally, the findings obtained are used to elaborate, through an interpretative process, a theoretical explanation about who, and how, participates in the allocation of external funding to innovative ventures in the bio-pharma sector.

1.4 Findings

The information obtained from the interviewees is classified into seven emerging themes: i) knowledge about the sector (bio-pharma); ii) networking matters; iii) interactions (among players related to financing); iv) availability of financing sources and mechanisms; v) funding different venture stages; vi) characteristics of the investors; vii) trends of change in the bio-pharma industry.

The findings based on the evidence provided by the interviews can be summarily presented in the following terms:

- The knowledge of investors about the sector is essential for both funders and fundees in order to reach agreements on financing amounts and conditions and to steer the development of the projects;

- The existence of a knowledge-related network is significant for funders and fundees to access and update knowledge, to track records, to access and structure funding operations, and to enhance the capacities of project teams;

- Differences between generalist and specialised investors concern attitudes and efforts in creating and maintaining networking and knowledge access. Those differences can be further composed by variations in the investment base, the time horizon and the timing for investment, and certain preferences about the investment structure, stage for investment, and exit mode;

- Interactions about financing ventures include different players and roles and have a significant impact on the structure and time horizon of investment in innovation. Factors such as the availability of sources and mechanisms of funding and their keenness to finance certain innovative projects, as well as the setting in which actors and interactions take place also have an impact;
Some trends of change involve variations in the strategies and interactions of the different players that take into consideration the modifications of fellow agents and the emergence of different conditions and new players in a given setting.

1.5 Discussion

The discussion based on the findings listed leads to the proposal of considering the funding of innovation in science-based sectors (e.g., bio-pharma) under a systemic view. That essentially means that both venture owners and funders have a knowledge consolidation system and a set of characteristics which are central in their networking and interaction decisions and actions. The knowledge consolidation system, which changes in time, includes the knowledge needed to innovate and to fund and manage ventures, in the case of the owners, and the knowledge about a space’s science, finance and networking, in the case of potential funders.

I argue that funders are part of a financial layout which is characteristic of each setting and which is defined by the presence and funding readiness of potential financiers according to, among other things, certain characteristics of funders. Moreover, the investors’ knowledge consolidation system (IKCS) is the crucial element in the definition of two different types of investors (dedicated and generalists) based on two distinctive approaches (learning and shaping vs selecting) when it comes to allocating funds to innovative science-based ventures in a particular setting. This all involves deep variations in the motives, decisions, interactions and roles of funders concerning the financing of innovative ventures in science-based sectors.

1.6 Outline of the thesis

Chapter 2 presents a succinct characterisation of the sector examined in this case study-based research and, then, reviews two relevant strands of literature (selection and inducement) about how innovative ventures are funded, particularly in bio-pharma. The main problems of each explanation are discussed and the main
questions to be answered in the present document are posed. Moreover, a sectoral view framework is proposed in order to structure the discussion and find suitable answers to the research questions posed. Knowledge is considered to play a central role in this perspective and it becomes a pivotal element in our attempt to develop a better explanation on the financing of innovation.

Chapter 3 introduces the methodological framework of choice and explains the relevant characteristics of sampling, collection, and analysis of primary data. Specificities of analysis are shown to underpin the structure and explanatory substance of the findings that are found to support the explanation proposed. The thematic analysis methodology is illustrated by displaying the summarised results of the theme coding process: main themes, their underlying issues and the hierarchical relationships that turn them into a coherent body of evidence.

In Chapter 4 a narrative is presented in order to incorporate and reflect the conceptual and functional details of the categories, ordering, and relationships established earlier. As a consequence, each of the following sub-sections develop the array of emerging themes through statement-based stories that create a coherent picture of how and by whom are financing decisions to support innovation in the biopharmaceutical sector made. Lastly, a summary of the main issues is done to support the proposal introduced in the last chapter.

Chapter 5 proposes a sector-based perspective and explains the basic traits, working and consequences of: a) innovative firms’ knowledge; b) investors’ knowledge; c) availability and readiness of funders; d) networking and interactions; and e) mutations and learning.

The main aspects of investors’ strategy are discussed regarding: a) the connections between networking and the investors’ knowledge consolidation system; b) the distinction between generalist and dedicated investors, and c) some key aspects that may require further thought. The most important implications of adopting a sectoral perspective are then presented as well as further details on how this view enhances the systemic (SSI-based) view and several concepts applied to the biopharmaceutical industry as sustained by a few prior works.
Lastly, Chapter 6 lists the main conclusions reached, the shortcomings of this research work, and the new avenues of research that expect to be undertaken to further develop these ideas and their implications.
2. LITERATURE REVIEW

2.1 Introduction

There are several essential questions whose convoluted answers belie the apparent ease with which financing innovation in a sector such as bio-pharma apparently takes place. Who decides if money is to be put into an innovative bio-pharma project? How large an amount and for how long? How are such decisions made? How can funders make sure about the quality of ventures whose potentiality is often only praised by their creators?

The complexity of these issues is reflected by the current concern among many specialists that investment in bio-pharmaceutical innovation is not sufficient, particularly in the case of early stage ventures, because late stage projects with lower risk and uncertainty and greater asset support attract substantially more investors, though returns are surely inferior. This, a very common feature among financiers nowadays, might however endanger the forthcoming development of innovation and the very future of the sector, at least in countries across Europe, and concede the advantage to other current global players such as the US or emerging powers such as Canada, Australia and South Korea.

In order to understand what lies behind this, this chapter will present, in Section 2, a brief characterisation of the empirical setting of the research (the sector of choice for the case study). Section 3 offers a review of the existing literature on how are innovative ventures funded, with particular reference to the sector under study, by examining two different approaches: selection and inducement. Section 4 will discuss the main problems of these explanations and, therefore, will make explicit the main questions that we intend to answer in this document. Section 5, in turn, will propose a framework (a sectoral view) that may make the discussion more structured and offer better answers to the problems posed. Finally, Section 6 will review the central role that knowledge plays in the sectoral perspective and how it can be a pivotal element in our attempt to develop a better explanation on the financing of innovation.
2.2 Bio-pharma: A snapshot of ideas and money

The bio-pharmaceutical sector\(^2\), particularly that of the UK which is the second strongest in the world and the first in Europe, faces a great concern derived from two risky issues spotted by analysts in relation to the current sectoral structure and activity. First, insufficient investment in biotechs (that usually possess early stage assets) and, second, a bias towards investing in assets in late stage development which occurs both in the US and Europe (Hellmann and Puri, 2000; Rosiello and Parris, 2009; European Commission – Enterprise and Industry, 2009; UnicornBiologics, 2010; Haslam et al., 2011; Hopkins et al., 2013\(^3\)). Thus, two issues closely related to the financing of the innovative activities in two different stages of the sector embody a wide scope worry about the mid-term future of the key activity in the industry: the creation of knowledge and the development of new products based on such fresh knowledge. The net effects of this all are still to be seen, but clearly these issues might cause the demise of the sector in the strongest bio-pharma-related economies, which creates a particular concern for the US and some European countries, as its portfolio as a whole might decrease significantly in the near future as long as the lower flow of assets in the development pipe will reduce its overall value over time. The final consequence may be only one, the decreasing importance of EU bio-pharma (in particular in the UK) as a global player to the advantage of its main competitors, especially the leading US and some emergent players in Asia, America, and Australia.

The only way to avoid this potentially disastrous situation is to generate new R&D projects which means raising fresh funds for early stage research in biopharma SMEs in order to sustain the network within which companies, SMEs and start-ups in particular, operate since it is “... fragile and when financially distressed, the intangible asset base either corrodes or is lost” (Haslam et al., 2011: p. 5). This issue becomes particularly pressing given the long-term orientation and the high costs of

\(^2\) A definition of this space is not straightforward, neither in terms of research nor in terms of business activities, and there are at least two narrow and broad definition variants (see European Commission – Enterprise and Industry, 2009). We, therefore, subscribe here the discussion around the meaning of the term and use it as referring essentially to therapeutics (see Hopkins et al., 2013).

\(^3\) Such a fact is entirely consistent with the historical situation described by authors such as Oakey (2003) regarding the meagre funding available for SMEs, start-ups included, classified as new technologies-based firms (NTBFs) in the UK, for instance.
bio-pharmaceutical R&D\(^4\) in general (DiMasi and Grabowski, 2007; European Commission – Enterprise and Industry, 2009; Scherer, 2010).

Some comparative figures may be useful to understand the current profile and the general dynamics of the industry. The bio-pharmaceutical sector exhibits some very specific characteristics among the so-called high tech sectors: High level innovation (fundamentally uncertain and risky) is a common costly and long-term activity, heterogeneity in and interaction among firms, funders and other players create high complexity in funding decision-making, firm strategy regarding radical innovation appears highly complex and emergent (milestones are fundamental), funding mechanisms borrowed from other sectors (e.g., VC) are under growing criticism, reactions to a changing environment promise further transformations at a global level (Scherer, 2010; Hopkins et al., 2013).

Moreover, recent figures point towards some dynamic trends currently under development (European Commission – Enterprise and Industry, 2009; UnicornBiologics, 2010; Hopkins et al., 2013). Worldwide, relatively small biotech companies still own more than seventy-five percent of the medicines in the development portfolio, while the large pharma share is just about thirteen percent, which means that the former companies hold around sixty percent of the estimated asset value, whilst the latter own no more than thirty percent. The global configuration of the sector indicates a clearly dominant position of the US, where more than half of the companies developing new medicines are located and nearly half of the assets under development are held, though the different areas (antibodies, recombinant proteins and peptides, therapeutic vaccines, prophylactic vaccines, gene/cell therapies) are more homogeneously distributed among the US, Europe (mainly UK, Denmark, France, Germany, and Switzerland), and the rest of the world (chiefly Australia, Canada, and South Korea) (UnicornBiologics, 2010).

Within Europe, UK bio-pharma in particular is a highly competitive sector (see Rosiello and Parris, 2009) with a number of well-known, large, international players and other relatively smaller enterprises that invest heavily in R&D (approximately one hundred and thirty companies according to the 2010 Report by the Department for Business, Innovation and Skills). Other strong European players trailing behind

\(^4\) Estimates from rather recent studies indicate that the total capitalised cost per approved new molecule produced in bio-pharma is close to USD 1,240 millions, not very far from the cost for pharmas (just over USD 1,300 millions) (DiMasi and Grabowski, 2007).
the UK are Denmark, France, Germany, and Switzerland. Although R&D activity is very significant in the European and the UK bio-pharmaceutical sector in particular, it is heterogeneously distributed; about ten percent of the world total number of biological medicines are developed by UK companies for a portfolio value equivalent to just over ten percent of the global value. That essentially means that, from a worldwide perspective, the UK biological medicines portfolio “is second only to the US with respect to the percentage of total assets in development and the relative value of those assets at each stage ... [and] with regard to the number of assets in development”, though the areas of development in the UK differ from those in continental Europe and the rest of the world (UnicornBiologics, 2010).

However, when location is taken into account, not more than six percent of the total number of assets in development are owned by UK biotech firms, which amounts to just four percent in asset value, in comparison to over fifty percent in the US and around twenty two percent in continental Europe and the rest of the world. Internally, and markedly different from the US and the EU cases, less than a quarter (23%) of the portfolio value is owned by biotechs and more than half of it (57%) belongs to large pharma companies (US: 26%; EU: 19%) (UnicornBiologics, 2010: pp. 2-3).

Also, the industry has gone through different epochs regarding the availability of funding, particularly for innovative projects (i.e., R&D) and, despite the strong discussion about the effects of the so-called “bio-tech revolution” and the debate about the relative advantages of small and medium-sized firms over big companies, investors have maintained their interest in the industry and, with remarkable national differences (e.g., the US leads world investments in life sciences with two thirds of the total venture capital investments, while the share of the EU members is only 20%; although irregular over time, IPOs are much more common in the US than in Europe), capital continues to flow towards the sector (European Commission – Enterprise and Industry, 2009; Lazonick and Tulum, 2011; Hopkins et al., 2013).

In short, it can be said that the global bio-pharmaceutical industry is overall dominated by the United States and, in Europe, by the United Kingdom. Other European countries such as Denmark, France, Germany, and Switzerland are clustered in a third ranking slot with Australia, Canada, and South Korea (See Tables 1 and 2). Additionally, the importance of biotech firms, especially small ones, is also well established worldwide (see Tables 3 and 4).
However, it is also evident that there are some differences in terms of both the distribution and the value of assets concerning the different stages of development, among which there may sometimes be overlaps (Scherer, 2010); the US industry and the rest of the world exhibit a more balanced structure when comparing early (pre-clinical and clinical I) and late (clinical II, clinical III and pre-registration) phase projects, while Europe and UK bio-pharma in particular exhibit lower figures in terms of the total number and the net present value of the initial stages compared to the later ones (See Tables 1 and 2 – non-shaded vs shaded stages). These figures clearly point in the direction of the concern deriving from a shortage of funding of early stage projects and a marked preference for funding late stage ones.

Table 1 – Percentage distribution of global total number of biological medicines in development by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Preclinical</th>
<th>Phase I Clinical Trial</th>
<th>Phase II Clinical Trial</th>
<th>Phase III Clinical Trial</th>
<th>Pre-registration</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (Others)</td>
<td>20</td>
<td>21</td>
<td>20</td>
<td>27</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>RoW</td>
<td>26</td>
<td>19</td>
<td>25</td>
<td>16</td>
<td>31</td>
<td>24</td>
</tr>
<tr>
<td>UK</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>USA</td>
<td>47</td>
<td>53</td>
<td>45</td>
<td>44</td>
<td>38</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: Unshaded = Early stage
Shaded = Late stage

Source: Adapted from UnicornBiologics (2010)

Table 2 – Percentage of total value (rNPV) for biopharmaceutical assets in each stage of development globally

<table>
<thead>
<tr>
<th>Region</th>
<th>Preclinical</th>
<th>Phase I Clinical Trial</th>
<th>Phase II Clinical Trial</th>
<th>Phase III Clinical Trial</th>
<th>Pre-registration</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (Others)</td>
<td>19</td>
<td>25</td>
<td>23</td>
<td>22</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>RoW</td>
<td>26</td>
<td>21</td>
<td>25</td>
<td>17</td>
<td>31</td>
<td>24</td>
</tr>
<tr>
<td>UK</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>13</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>USA</td>
<td>49</td>
<td>44</td>
<td>42</td>
<td>48</td>
<td>37</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note 1: rNPV stands for risk-adjusted net present value
Note 2: Unshaded = Early stage
Shaded = Late stage

Source: Adapted from UnicornBiologics (2010)
Table 3 – Percentage of total value of global portfolio owned by each company type from different regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Biotech</th>
<th>Large Biotech</th>
<th>Pharma</th>
<th>Large Pharma</th>
<th>Other</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (Others)</td>
<td>27</td>
<td>2</td>
<td>14</td>
<td>13</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>RoW</td>
<td>22</td>
<td>11</td>
<td>65</td>
<td>26</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>UK</td>
<td>4</td>
<td>7</td>
<td>14</td>
<td>22</td>
<td>78</td>
<td>12</td>
</tr>
<tr>
<td>USA</td>
<td>47</td>
<td>80</td>
<td>7</td>
<td>39</td>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>*100</td>
</tr>
</tbody>
</table>

Source: Adapted from UnicornBiologics (2010)

Table 4 – Distribution of the total value of portfolio within each company type from different regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Biotech</th>
<th>Large Biotech</th>
<th>Pharma</th>
<th>Large Pharma</th>
<th>Other</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (Others)</td>
<td>78</td>
<td>1</td>
<td>3</td>
<td>19</td>
<td>0</td>
<td>*100</td>
</tr>
<tr>
<td>RoW</td>
<td>54</td>
<td>2</td>
<td>11</td>
<td>31</td>
<td>1</td>
<td>*100</td>
</tr>
<tr>
<td>UK</td>
<td>23</td>
<td>3</td>
<td>5</td>
<td>57</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>USA</td>
<td>64</td>
<td>9</td>
<td>1</td>
<td>26</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Adapted from UnicornBiologics (2010)

Notes for Tables 3 and 4:
* rounded total
Biotech: Company portfolio comprised predominantly of assets derived using biological means
Pharma: Company portfolio comprised predominantly of assets derived synthetic/chemical means
Large Biotech: Revenues > USD1 billion in 2007
Large Pharma: Revenues > USD3 billion in 2007

Note for Tables 1 to 4: The figures cited are the result of an exercise by which “(a) estimation of the value of biological medicines in development globally has been conducted using a risk adjusted net present value model (rNPV).” (p. 2) The portfolio valuation was conducted by the authors on the basis of primary pipeline data sourced from PharmaProjects database (cutoff at July 2009) and supplemented by in-house knowledge accumulated at UnicornBiologics. All the data processing was done by the authors of the Report. As far as we know, these figures have not been challenged by the industry.

That worrying impression is further reinforced, especially for the UK, by the figures relative to value of the portfolio owned by biotechs (typically SMEs and start-ups) compared to that held by large biotech and large pharma (see Tables 3 and 4); for instance, according to Table 4, large biotechs and pharmas (columns two and four combined) have the lion’s share in the UK at the expense of biotechs (column one) (Table 4: 60 vs 23 per cent of total value of portfolio), while the case is exactly the opposite in the US (Table 4: 35 vs 64 per cent) and even in the rest of Europe (Table
Thus, it seems difficult to disagree with Haslam et al. (2011) that the complex bio-pharma business model is “a delicate balancing act between, on the one hand, progressing product along its development pipeline, and on the other, securing sufficient cash resources to finance this product development.” (p. 3). We could only add that such an act is not only in the hands of one player because the biopharmaceutical sector includes so many multifaceted stakeholders (e.g., universities, medical research centres, charities, national and regional government, regulatory bodies and agencies, big pharmas and SMEs, business angels, venture capital and other investors) and several of them are usually involved in the securement of the financial resources that are needed to keep the balancing act going in the long term.

Therefore, the importance of studying the financing of innovation in science-based sectors, such as bio-pharma, goes well beyond the current study of funding gaps (which some actors say do not even exist), the building of balanced investment portfolios to secure profits or the plain historical review of the trends and changes in the sector. A wider, yet deeper, comprehension of the complexities that are inherent to a sector and an activity based on the continuous advance of knowledge and its applications by multiple interdependent distinctive actors in ever changing settings clearly brims over the rather simplistic finance-related questions about how much (more or less) money to put in in order to obtain a certain higher profit rate. The very existence of the sector as it is and its transformation into something more akin to what venture owners, investors, policy-makers, and customers and users desire is at stake if better explanations, therefore improved strategic decision-making and implementation, are not offered so that the industry walks towards a sustainable future.

2.3 A State of the Art on the funding of innovation

The literature on the manner in which the financing of innovative projects is accorded can be described as following two trends. The first one (we will call it the selection approach) regards the possibility that either the potential fundees (the company or person that owns the project) or the potential funders (the investors)
choose the other party from a range of available possibilities; in simple words, project owners pick out who they want to be funded by or investors select a project they want to fund (Myers and Majluf, 1984; Amit et al., 1998; Gompers and Lerner, 2001; Eckhardt et al., 2006; Ullah et al., 2009; Knockaert, Clarisse, and Wright, 2010; Mina and Lahr, 2011; Bertoni and Tykvova, 2012). The second one (we will call this the inducement approach), instead, refers to project owners or investors that actively look for an “opportunity” and, once they spot it, they try to talk the other party into entering the funding relationship; in other words, project owners try to persuade investors to put their money into it or investors attempt to convince owners that they offer the right financial back up (and eventually other co-adjuvant support) to their project (Bygrave and Timmons, 1992; Gompers and Lerner, 1998; Powell et al., 2002; Gulati and Higgins, 2003; Hallen, 2008; Bertoni et al., 2011; Hallen and Eisenhardt, 2012).

a. The Selection Approach: Pecking Order and Passive Search Theories

There are two types of explanations behind this research line. According to the first one, the project owner(s) select what they think is the most convenient funding source from a range of available options. This is the basic idea behind the Pecking Order Theory (POT) originally developed by Myers and Majluf (1984) and complemented by other authors (e.g., Baeyens and Manigart 2005; Vanacker and Manigart, 2010; Cassia and Minola, 2011). In short, the POT focuses on the capital structure of long-term real investment of firms such as R&D, which is the most common proxy for innovative projects, and establishes that:

“... companies prefer to finance new investments with retained earnings, which are not subject to asymmetric information problems. When internal funds are insufficient to meet the financing needs, managers will turn to more costly outside funds. In this situation companies are expected to issue the safest securities first as these will suffer less from information asymmetries and hence be subject to lower premiums. This implies managers will first raise debt financing [bond issues] and only consider new equity [stock issues] as a last resort. The resulting financing hierarchy is often referred to as a pecking order and is one of the most influential theories in the financial literature.” (Vanacker and Manigart, 2010 – p 55. Underlining introduced).

This preferential funding order was later enhanced through the inclusion of bank debt, which is primarily used by low risk businesses whilst external equity is used by high risk businesses. External equity seems to be also particularly important for
unprofitable companies, firms that invest heavily in intangible assets, companies with high debt levels and limited cash flows or businesses subject to high failure risk. Thus, external equity seems crucial as it allows high-growth businesses to undertake investment and grow beyond their debt capacity (Baeyens and Manigart 2005; Vanacker and Manigart, 2010; Hall and Lerner, 2010). There is also confirmation that the POT ordering of funding preferences applies likewise to small firms (Norton, 1991; Holmes and Kent, 1991; Scherr et al., 1993; Chittenden et al., 1996; Berggren et al., 2000; Howorth, 2001) and to start-ups (Cassar, 2004; Paul et al., 2007) in general, although certain specificities such as the existence of debt floor targets and owners’ personal preferences about lifestyle, financial security or risk seem to matter.

Studies dealing with the funding of R&D activities (Westhead and Storey, 1997; Guiso, 1998; Giudici and Paleari, 2000; Grilli, 2005; Colombo and Grilli, 2007; Freel, 2007) have confirmed the existence of a hierarchical set of preferences in technology-based firms from different high-tech sectors (from bio-tech, to computer software, to Internet services) regarding the use of different funding sources more or less in accordance with the POT ranking. Other reports have recognised that factors such as the managers’ differing expectations on future liquidity constraints, the characteristics of stockholders/managers, tax depreciation schemes applied to R&D tax incentives, or the appearance of new funding sources may alter the POT funding

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5 Myers and Majluf’s original six conclusive statements underlying the POT ranking are:

“1) It is generally better to issue safe securities than risky ones. Firms should go to bond markets for external capital, but raise equity by retention if possible. That is, external financing using debt is better than financing by equity.

2) Firms whose investment opportunities outstrip operating cash flows, and which have used up their ability to issue low-risk debt, may forego good investments rather than issue risky securities to finance them. This is done in the existing stockholders’ interest. However, stockholders are better off ex ante - i.e., on average - when the firm carries sufficient financial slack to undertake good investment opportunities as they arise. The ex ante loss in value increases with the size of the required equity issue. Thus, increasing the required investment or reducing slack available for this investment also increases the ex ante loss. In addition, numerical simulations indicate the loss decreases when the market’s uncertainty about the value of assets in place is reduced, or when the investment opportunity’s expected NPV is increased.

3) Firms can build up financial slack by restricting dividends when investment requirements are modest. The cash saved is held as marketable securities or reserve borrowing power. The other way to build slack is by issuing stock in periods when managers’ information advantage is small; firms with insufficient slack to cover possible future investment opportunities would issue in periods where managers have no information advantage. However, we have not derived a generally optimal dynamic issue strategy.

4) The firm should not pay a dividend if it has to recoup the cash by selling stock or some other risky security. Of course dividends could help convey managers’ superior information to the market. Our model suggests a policy under which changes in dividends are highly correlated with managers’ estimate of the value of assets in place.

5) When managers have superior information, and stock is issued to finance investment, stock price will fall, other things equal. This action is nevertheless in the (existing) stockholders’ interest. If the firm issues safe (default-risk-free) debt to finance investment, stock price will not fall.

6) A merger of a slack-rich and slack-poor firm increases the firm’s combined value. However, negotiating such mergers will be hopeless unless the slack-poor firms’ managers can convey their special information to the prospective buyers. If this information cannot be conveyed (and verified), slack-poor firms will be bought out by tender offers made directly to their shareholders.” (pp 219-220).
preferences of innovative companies (Saltari and Travaglini, 2001; Hogan and Hutson, 2005; Hall and Lerner, 2010; Cassia and Minola, 2011; Nam, 2012)⁶.

With reference to the bio-pharmaceutical sector specifically, Ullah et al. (2009) confirm POT alterations in the financing of bio-tech small firms in the UK. They conclude that bio-tech start-ups and SMEs seek VCs and BAs at early stage (when such firms are more deeply financially constrained), while public sources (not explicitly included in the original POT!) are also considered important investors in the sector; founders, family, friends, and fools (the four Fs in short) are regarded as less important sources of funding than they are for other sectors (e.g., software). That is consistent with evidence from Europe that private equity and VC investment volume in life sciences and bio-pharma remain strong despite a small loss in volume, although it keeps focused on mature companies (Bertoni and Tykvova, 2012; Mina and Lahr, 2011).

The relevance of external new equity under the form of venture capital sourced through public and private investors (e.g., VC funds and BAs) in high tech sectors, particularly in the bio-pharmaceutical industry, is confirmed by Haslam et al. (2011) for the UK and Lazonick and Tulum (2011) for the US. Stock market IPOs in Europe, instead, do not appear as a strong funding mechanism currently (AIM, the biggest European technology market, has seen only 41 bio-pharmaceutical companies listed after 2010 (LSE/AIM data) out of 130 companies reported as top R&D bio-pharmaceutical investors in that period, according to BIS) due to costs and other reasons; however, they are a substantial mechanism in the US (Powell et al., 2002; Lazonick and Tulum, 2011). The spotlights, then, keep pointing at venture capital as the strongest bio-pharma funding source all over Europe even if there is a claim that “the profitability of the venture capital model and its long-term sustainability have recently been called into question and seriously tested by the current financial crisis” (Mina and Lahr, 2011).

In short, the POT ranking-based explanation for new and young companies in the bio-pharmaceutical sector (and probably other science-based industries) refers to entrepreneurs and firm managers preferring VC and BA funding as the best financing

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⁶ If truth be told, Myers and Majluf made it clear that they did not pretend to offer a universal explanation as can be understood from their final declaration that their conclusions are dependent on the assumptions specifically created for the model that they analyse and that such is just: “...one of many possible stories about corporate finance. A full description of corporate financing and investment behavior will no doubt require telling several stories at once.” (p. 220). This is a point which, in fact, we intend to make in this analysis.
option, followed by government money and IPO investors (which, in many cases, will be VCs as well). Alternative funders (the four Fs) and bank/bond-based debt are out of discussion, although debt mechanisms can be used by mature and big companies in the sector. The role and preferences of the funders are not considered at all (see footnote 2).

In the second explanation under the selection approach, potential external funders (investors) choose a project/company to fund from a range of available options that come forward seeking financing. This is the fundamental idea behind the Passive Search Theory (PST) view that is based on the tasks that financiers carry out in connection with their potential fundees.

The PST explanation is, in fact, summarily described in the conclusion of the staged selection analysis of new venture finance processes proposed by Eckhardt et al. (2006) on the basis of two sequential events whereby:

> “founders select ventures as candidates for external capital based on their own positive assessment of the ventures, while investors use objective characteristics of the ventures to select which ventures to finance from a pool of ventures that founders have put forth as candidates for external financing.” (p. 229)

Actually, economic theory recognises the importance of several VC roles and mechanisms created to deal with the agency problems associated to radical innovation (Gompers and Learner, 2001), knowledge gaps (the very basis of information asymmetries) included (Hall and Lerner, 2010). The VC literature considers that, beyond supplying funds for projects, financiers carry out two main supplementary functions\(^7\): scouting, which refers to “identifying future potential projects” through powerful screening capabilities (Chan, 1983; Amit et al., 1998; Gompers and Lerner, 2001; Knockaert, Clarisse, and Wright, 2010; Bertoni et al., 2011), and coaching, which may be identified with “helping realize that potential”\(^8\) (Gorman and Sahlman, 1989; MacMillan et al., 1989; Bygrave and Timmons, 1992; Sapienza, 1992; Barney and Busenitz, 1996; Sapienza et al., 1996; Kaplan and Strömberg, 2004; Bertoni et al., 2011).

\(^7\) Moreover, some authors consider that VC investors commonly perform also other functions such as monitoring (“controlling” to avoid moral hazard or the wrong use of the funds provided) (Sahlman, 1990; Gompers, 1995; Lerner, 1995; Hellmann, 1998; Kaplan and Strömberg, 2003, 2004) and certificating (“advertising” the good quality of a project/firm chosen so that any other interested investor will be attracted by the opportunity to throw money in (Megginson and Weiss, 1991; Stuart et al., 1999) or to network with potential customers, suppliers, and alliance partners) (Colombo et al., 2006; Hsu, 2007; Lindsey, 2008). Such functions are, of course, carried out after they have made the decision to fund a particular project/company.

\(^8\) Coaching, accordingly, generally involves providing selected companies with assistance for better strategic decision-making and allowing them access to a wider network of business contacts once they have been selected to receive funding.
Scouting is based on potential VC investors screening the projects/companies to determine which offers the most convenient investment opportunities and “cherry-picking” the best among the bulk of investment projects submitted by venture owners (Bertoni et al., 2011). The methods to do such a selection are complex (Chan, 1983; Freeman and Soete, 1997; Amit et al., 1998; Zacharakis and Shephard, 2007), may imply diverse criteria such as profitability, the size of the final market, the quality of the bioscience, the characteristics of the regulatory regime, the degree of readiness of investee firms (Rosiello and Parris, 2009), and do not exclude the use of intuition (“gut feeling”) as a decision-making factor (Zacharakis and Shephard, 2007; Yang et al., 2009).

In some cases, a stronger selection capability seems to effectively develop if underpinned by intensive investment experience (many operations), stage-diverse experience (investing in both early and late stage projects), and syndication (particularly with independent VCs) as long as uncertainty remains rather low. This would be the case of CVC investment, for instance (Yang et al., 2009).

Of course, the final decision to fund a project/company takes into account a wider arrangement of relevant factors, but it may be strongly based on one type or set of relevant criteria. Thus, early stage investors in high tech sectors, for example, have been classified according to their dominant selection criteria into: i) technology investors (choice based on technology protection, investor-entrepreneur contact, uniqueness of product); ii) people investors (choice based on the entrepreneur’s leadership and the quality of the team); iii) financial investors (choice based on the potential return of projects) (Knockaert, Clarisse, and Wright, 2010). Late stage investors, instead, seemingly fit better the financial investors category led by factors such as lower risk (entailing lower return) and a shorter investment horizon (less distance to market).

Some works propose that technology VC investors in particular differ from traditional investors in their greater investment management and consulting experience (Knockaert, Clarisse, and Lockett, 2010) and that such dissimilarities may be associated with different fund selection behaviour when it comes to deciding which technology-based firms to invest in (Knockaert, Clarisse, and Wright, 2010).

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9 Rosiello and Parris (2009) term “classic” VC those VC funds whose investment is focused on ventures at seed, start-up, and expansion stages and is considered different from “merchant” VC which is oriented towards later stages, management buy-outs and buy-ins included.
Also, some study results claim that there is evidence about the role of “co-location between investee companies and leading investors, with a marked inclination to target DBFs [dedicated biotech firms] located in bioscience-intensive regions” (Rosiello and Parris, 2009: p. 203; Powell et al., 2002) that would explain the strength of the bio-pharmaceutical cluster and the propensity to invest in given areas (such as the “Golden Triangle” in the UK or specific areas such as Boston in the US). This would mean that investors can more easily perform due diligence on potential investment opportunities through a local network of contacts.

In short, PST proposes that entrepreneurs/firms self-select the projects to be proposed to potential investors who will simply deploy their arsenal of “objective” criteria in order to screen the best projects according to their knowledge and preferences. The only other “interaction” instance regards the geographic closeness that is critical in some cases for VC investors’ decision (Powell et al., 2002).

b. The Inducement Approach: Catalyzing Strategies and Active Search Theories

This approach is also sustained by two types of explanations. The first one, places most of the initiative on project owners, once again, by suggesting that firm management can efficiently obtain access to external funding by using either already existing strong direct ties with funders or, alternatively, by drawing on catalyzing strategies “when firms lack strong direct ties or when desired potential partners lie outside the local network” (Hallen and Eisenhardt, 2012). Nothing is, however, actually said about the approach when direct ties do exist so the idea that funding may be already granted in such a case may easily slip through.

The Catalyzing Strategies Theory (CST) is defined in terms of “behaviours by which executives advantageously shape their firm’s opportunities or others’ inducements to form ties” with potential financiers (Hallen and Eisenhardt, 2012: p. 42). The initiative is mainly attributed to the firms and consists of a number of phases along a path in which strategies are ordered in a temporal sequence:

i) phase one (casual dating) is defined as “an executive’s informal but deliberate, repeated meeting with a few potential partners prior to attempting to form a formal tie”;

31
ii) phase two ( timing around proofpoints and scrutinizing interest ) refers to “a positive signal of substantial venture accomplishment of a critical milestone (proofpoints) by external actors” before formally seeking investment ties, which means the validation of such accomplishments by a third party (not an internal actor) that may lead a potential funder to study the establishment of investment ties; this is where scrutinizing interest (“taking actions to discern potential partners’ actual interest in a tie”) turns up;

iii) phase three ( crafting alternatives ) takes place when spotting serious interest from at least one investor as a consequence of activities aimed at “developing multiple routes to end the tie formation process”;

iv) phase four corresponds to proper and successful investment tie formation.

The authors consider also the existence of alternative inefficient firm strategies in each phase such as just-in-time ties, timing around resource needs, shopping for ties, and hoping for ties (p. 54), which are obviously not as effective as the CS set. Thus, the leading roles prescribed in these strategies (adding potential partners to network, sending strong signal of quality, culling potential partners with faked interest, sending strong signal of scarcity) are all essentially endorsed to firms’ management whilst the potential investors appear as essentially reactive (Hallen and Eisenhardt, 2012).

In short, the CST proposal consists of two routes that entrepreneurs/firms can follow to secure funding for their innovative projects: they can resort to existing contacts or, if they do not have any, they can explore, lure and scrutinise the interest of potential investors and craft alternatives to finally establish a successful investment tie. References to the role of funders here seem limited to sending signals about their (true or fake) interest in the projects shown to them.

The Active Search Theory (AST) is built upon the roles of financiers (once more VCs in particular) but, unlike Eckhardt et al.’s (2006) formulation, it implies VCs actively scouting for projects/companies to screen according to their objective selection criteria. This is not a small difference and the shift from a passive to an active search attitude is partly justified in the literature by the very high pay-off expected by investors (given the very high risk of the projects) and the success-to-failure ratio, which is said to be of about two in ten (Bygrave and Timmons, 1992; Gompers and
Lerner, 1998), that makes it necessary in order to build a big enough portfolio of projects that can help manage risk in a better way.

Just like the PST explanation, attracting money by firms is difficult and heavily conditioned by a successful track record of identifying “winning” projects to submit for consideration and generating enough profit to potential funders; furthermore, the AST implies that VC investors must show their own track record in two fronts: spotting winners and generating rewards for their limited partners (Powell et al., 2002) and, besides this, giving evidence of the coaching added value they can offer to venture owners. This definitely conditions the raising of funds and the access to the best opportunities waiting to be “cherry picked”.

Summarily, AST enlarges the PST proposal by giving VC investors the initiative to seek appropriate projects and by unveiling the funders’ need to comply, in turn, with some demanding specific conditions (a good track record) that influence their roles as fund raisers and investors.

Despite the interesting and detailed views proposed, a critique of the approaches considered above (See Table 5 for a summary) can be formulated in terms of lack of balance (i.e., one party’s initiative prevails), bias (i.e., the domineering party “imposes” equally overbearing criteria), and disembeddedness (i.e., milieu factors and their changes over time are usually ignored).

These explanations are unbalanced in general because they essentially concede a domineering role to just one of the parties, be it the project owners (entrepreneurs or company managers) in the case of POT and CST or the potential financiers (VC funds in particular) in the case of PST and AST. In fact, the former explanations see project owners either picking out their preferred type of funders on the basis of their own (project owners’) preferences and convenience or trying to persuade either known or unknown potential funders about the quality of their projects. In such a perspective, external financiers are passively waiting to be picked out or convinced about the convenience of a particular innovative project. In the latter case, instead, the external funders do all the “objective” work required to screen out “bad” ventures and retain “good” ones for funding among those forwarded by project owners and only in the case of PST do venture owners play a role when they self-select the projects to be submitted to external funders; that role, however, seems only a
formality if compared to the “objective” and definitive role of investors. Likewise, under CST, investors only incidentally demonstrate their interest (indeed, they are scrutinised for interest by venture owners), but otherwise it falls onto the entrepreneurs/managers to device the appropriate strategies to entice the investors’ interest in the projects.

Table 5 – Main theoretical explanations on innovation funding in bio-pharma

<table>
<thead>
<tr>
<th>EXPLANATION</th>
<th>POT</th>
<th>PST</th>
<th>CST</th>
<th>AST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Player</strong></td>
<td>Entrepreneurs/Firms</td>
<td>Investors</td>
<td>Entrepreneurs/Firms</td>
<td>Investors</td>
</tr>
</tbody>
</table>
| **Strategic Issues** | Ranking of bio-pharma venture owners’ funding preferences*:  
  i) VC & BA funding;  
  ii) Public funding;  
  iii) [IPOs] | “Objective” selection criteria:  
  i) Profitability  
  ii) Size of final market  
  iii) Quality of bioscience  
  iv) Characteristics of the regulation  
  v) Readiness of investee firms  
  vi) Co-location  
  vii) Intuition | Firm executives’ behaviours to shape their opportunities or investors’ inducements to form ties:  
  i) casual dating  
  ii) timing around proofpoints and scrutinizing interest  
  iii) crafting alternatives  
  iv) investment tie formation | “Objective” selection criteria:  
  i) Profitability  
  ii) Size of final market  
  iii) Quality of bioscience  
  iv) Characteristics of the regulation  
  v) Readiness of investee firms  
  vi) Co-location  
  vii) Intuition | PLUS | Project submission by entrepreneurs/firms | Track record in spotting winners and generating rewards for limited partners | Active scouting of investment opportunities | Track record in spotting winners and generating rewards for limited partners + evidence of coaching added value offered to venture owners |
| **Rationale** | Entrepreneurs/Firms choose their funders on the basis of their preferences, including costs and firm control | Entrepreneurs/Firms submit projects and funders “cherry pick” the best according to “objective” screening criteria such as: profitability, market size, quality of bioscience, characteristics of regulation, readiness of investee, intuition, co-location | Entrepreneurs/Firms lacking direct ties to funders try to attract investors through specific strategic behaviours | Funders actively search for ventures to fund and select the best according to “objective” screening criteria such as: profitability, market size, quality of bioscience, characteristics of regulation, readiness of investee, intuition, co-location |
| **Key Authors** | Myers and Majluf (1984)  
  Ullah et al. (2009)  
  Mina and Lahr (2011)  
  Haslam et al. (2011)  
  Chan (1983)  
  Amit et al. (1998)  
  Gompers and Lerner (2001)  
  Knockaert, Clarisse, and Wright (2010)  
  Hallen (2008)  
  Gulati (1995)  
  Amit et al. (1998)  
  Gompers and Lerner (1999 & 2001)  
  Knockaert, Clarisse, and Wright (2010)  
  Bertoni et al. (2011)  
  Bygrave and Timmons (1992)  
  Powell et al. (2002) |

* Different from the standard POT ranking of preferences originally established by Myers and Majluf (1984).

Source: Author’s own elaboration
2.4 Limitations of these approaches

Concurrently, these explanations are seriously biased since, under the first two perspectives (POT and CST), no criteria other than the preferences/convenience and the initiative of the project owners is considered necessary to obtain funding for the ventures. Nothing is said in the POT, for instance, about the criteria of funders or their will to finance a particular project (it may well be the case that a particular financier or category of financiers is not interested at all!); they are simply chosen because they are convenient according to the calculations of the venture owners. The second explanation (CST), instead, places all the importance in the development of inducement strategies on the side of project owners, while funders are only mentioned when they are scrutinised for a signal of interest (which might even be fake as the authors recognise). Under PST and AST, conversely, VC funds use an “objective” set of criteria to value the projects (included the teams behind them and the science and technology underpinning them) submitted by venture owners and no other interaction with them (except for the initial contact sought after by the venture owners or by the investors themselves) or further need for information seems indispensable to reach a decision, although AST seems to give some wider room for info exchange as investors also advertise their experience.

Finally, these explanations usually ignore the milieu factors and their changes over time so the decisions about innovative project funding made either by the venture owners or by the external funders are disembedded concerning a number of issues that are decisive. Are, for example, the selection criteria of funders or the preferences and convenience of project owners fixed over time so they are applied in whatsoever circumstances no matter what has changed even in connection with the funders or the owners themselves? Do venture owners select funders and investors select projects on the basis of the same criteria even if internal and external circumstances have mutated or new actors have appeared (e.g., regulation or regulatory bodies, macro or sectoral factors)? Do they all make the same decisions or use the same criteria even if the projects under consideration are set at different stages or the investors are going through diverse moments of their investment cycle (VCs in particular given their limited time investment horizon)?

Actually, only CST makes an explicit reference to social embeddedness and its complementariness with signalling actions (e.g., proofpoints) and even a temporal
order dimension (timing) is called for to support the proposed explanation (Hallen and Eisenhardt, 2012: pp. 55-56). Yet, no consideration of mutations of such factors or the appearance of new actors and factors over time is held.

Moreover, these explanations about the funding of innovation do not consider in depth the importance of the actors’ characteristics themselves (i.e., the ventures and the investors), their role in the manner behaviour is structured (e.g., how do age and experience affect the search for funding or for investment opportunities?), or their impact on the way the funding ties are shaped, and the way they may change.

Consequently, unbalancedness and bias, as discussed here, suggest that each party makes decisions independently and without further interaction with the other “involved” organisation. When that is considered outside a particular milieu and without reference to time-related changes, the explanations become brittle, even if partially correct, because what may be true in terms of the trends and their underlying causes and factors at a given time becomes hard to explain under different conditions.

A good illustration is provided by the difficulty that these theories face when trying to explain certain innovation funding facts. For example, they are not clear about why initial public offerings (IPOs) through common or technology-specialised stock markets are preferred by bio-pharma ventures and investors in some countries/economies and not in others that seem to be similar enough or why they are more or less widely used during a particular period and not in other; they cannot either explain why State VC and other official funding may have so different uses and impacts in two different regions within a same country or for ventures at a different stage or, maybe a worse case, why some projects that are left unfunded (rejected) by some investors are deemed worthy (accepted) by other financiers.

Furthermore, given the succinct characterisation of bio-pharma presented above (see section 2.2) about how money and ideas come together and the particular frailty of R&D funding in the case of small firms and start-ups, it is not surprising that a significant number of issues may be put forward that raise relevant questions which are, so far, left unanswered in terms of the existing explanations.

By way of illustration, we wonder about the possible response to some issues that concern the funding of innovation in bio-pharma and emerge from the examination
of the extant literature, but that we have not seen posed, let alone answered, anywhere. For instance, if experts on the sector have highlighted that actors are varied and heterogeneous, why do studies on the funding of innovation in bio-pharma only use two broad categories such as firms and venture capitalists as the only players? How does the consideration of different actors and roles affect the explanation of innovation funding in this sector? If regulation, intellectual property rights, and national health systems are, among others, central institutional factors in bio-pharma, why is their role only partially mentioned in some papers (e.g., Rosiello and Parris, 2009) and completely unaccounted for in most others? What is their impact in terms of innovation financing? Is it enough that one party (or both) put their preferences and criteria on the table to secure a funding deal? What kind of process ensues after the two sides establish contact? If knowledge is at the core of the industry, what role does it play in the definition of innovative project funding? Moreover, being new knowledge the basis of innovation in bio-pharma, how is it involved when potential investors with different views and expectations assess innovative projects?

Moreover, if the sector has historically gone through several stages and is different from country to country (e.g., McKelvey et al., 2004), how may funding decision processes be modified over time or digress in different settings? Do acting parties (e.g., firms, financiers, policy-makers) keep their preferences and criteria unaltered over time and despite transformations of the setting? Why, for instance, is funding bio-pharma innovation in the UK different from the US if the British “sectoral model” has strived to follow that of the US?

We think that the extant explanations on the funding of innovation in the biopharmaceutical sector (and in most science-based industries for that matter) exhibit serious limitations to answer these, and possibly other, enquiries. The account provided by the existing literature is either incomplete or it cannot address properly the issues raised here and possibly others. Thus, it can be stated that there is a gap in the explanations proposed about the funding of innovation concerning the process and the bases for such decisions to be reached with the participation of both venture owners and potential investors and, potentially, other actors. Moreover, the reasons and procedures behind such decisions should also be considered in the light of the changes that occur over time and that regard the central actors of the decisions and
the factors that compose the milieu in which all happens and that, of course, should have some impact on the decision-making itself.

The theoretical void undealt with by the existing explanations is so big that we think it is worth going back to the basic issues. It is not just a matter of asking additional complementary questions or trying to precise a few obscure details about the current explanations. Instead, we think, a wide and deep attempt at reflecting on the fundamental question of what actors and processes underlie this strategic issue and how do they relate to each other and unfold over time is a must. Accordingly, this gap leads to the essential questions that will be dealt with in this research: Who (given the wide variety of actors) participates in the allocation (or refusal) of external funds to innovative projects in the bio-pharmaceutical sector (and science-based sectors in general) and how do the intervening players relate to each other and to their milieu in order to reach such decisions?

Furthermore, given the fact that both the selection and the inducement approaches contain an explicit contradiction as long as the explanations covered fail to produce a systemic analysis (see the oversimplification via POT and CST favouring solely the project owner’s perspective and PST and AST supporting exclusively the financier’s viewpoint), it is only natural to ask whether truly the initiative of only one side (based upon a given set of preferences) can successfully activate the financing mechanisms of innovation in science-based sectors such as bio-pharma?

The first two questions are meant to examine the different players and their characteristics and to reflect on their actions and interactions, whilst the last one is aimed at understanding the dynamics whereby the funding of innovation comes to be. To start with, it is clear that our questions imply a de facto statement about the excessive oversimplification involved by the consideration of only two actor types and almost exclusively one sided criteria to explain a process that should be complex due to multiple possible actions and interactions among many more players in a changing context. Moreover, we think that the convergence of two strategic activities for any organisation, allocating resources and developing innovation, involves much more than what is present in the current explanations.

2.5 A Framework to Proceed Further: Sectoral Systems of Innovation
The decisions involved in the financing of innovative projects are not simple. From the explanations discussed in the previous section of this chapter, it is straightforward that such decisions involve multi-step procedures (decisions as a process) and interactions among a number of actors (decisions as a set of relations amongst agents). In fact, even in the case of heavily one-sided theories such as POT and CST, in which the initiative lies with venture owners while potential funders are essentially passive, establishing a ranking of the preferred funding sources or crafting the best strategies to attract them so they throw money into a project involves a procedure based on gathering and managing information, using judgment, making choices, and implementing the decision that, in this case, inevitably involves interacting with a second party at least to properly form the investment tie (Hallen and Eisenhardt, 2012).

Now, tie formation goes well beyond “getting the money” as PST and AST unveil. Once the projects to be funded are selected by using whichever screening criteria are deemed appropriate (another process in itself), coaching by the investors ensues and that probably includes or complements monitoring, certificating and even facilitating networking as explained earlier. Thus, interactions are a key issue during the formulation and implementation of decisions about the funding of innovation.

Furthermore, making and implementing decisions is by no means a unidimensional, monodisciplinary issue (see Einhorn and Hogarth, 1981). But, how can then these decisions be understood without falling once more into the unbalancedness, bias and disembeddedness of the existing explanations? We think that a wider picture offering a structured viewpoint in which the characteristics and behaviours of the different parties, the features of the setting in which they operate, and the principles that “govern” their interactions are integrated is necessary in order to generate a better understanding and a greater capacity to identify, formulate and implement more effective policies to support innovation through funding.

We also think that an analytic view based on a more integrative perspective such as the sectoral system of innovation (SSI) approach may contribute to build that necessarily more articulate and integral insight about the funding of innovation. It is so, firstly, because Malerba’s approach builds up on what he recognises as the two main traditions dealing with sectors: the industrial economics literature and an empirically richer albeit “much more heterogeneous, eclectic and dispersed” (2002,
line of sector case studies. Secondly because his proposal is based on a number of intellectual and theoretical contributions (mainly institutional and evolutionary economics, life-cycle literature, ideas on long-term industrial evolution, and innovation systems) concerning four essential aspects: i) the way in which change and transformation take place in sectors; ii) the way in which sectoral agents are integrated within certain dynamic boundaries and are interrelated by changing links and interdependencies; iii) innovation considered as an interactive process among agents; iv) learning, knowledge and behaviour accounting for agents’ heterogeneity in terms of experience, competencies, organization, and performance.

The definition of a sectoral system of innovation and production (SSI) put forth, in fact, essentially amounts to:

“... a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. Sectoral systems have a knowledge base, technologies, inputs and demand. The agents are individuals and organizations at various levels of aggregation, with specific learning processes, competencies, organizational structure, beliefs, objectives and behaviors. They interact through processes of communication, exchange, cooperation, competition and command, and their interactions are shaped by institutions. A sectoral system undergoes processes of change and transformation through the co-evolution of its various elements.” (Malerba, 2002: p. 248)

As the author himself recognises, the differences between this and the previous sector-focused approaches can be summed up in terms of a break with regard to certain positions assumed as settled by such views: i) the consideration of sectoral boundaries as static and well-defined and sectoral differences related to equilibrium structure dealt with in terms of technology and demand patterns, as well as sunk costs; ii) the scarce emphasis on the role of non-firm organizations, firm-related knowledge and learning processes, the wide range of relations among agents, and the transformations undergone by sectors regarding their boundaries, actors, products and structure; iii) the uni-dimensionality of most sector case studies (i.e., focus on innovation, competencies, productive structure) and their methodological non-comparability due to wide variations in questions, methodologies, and units of analysis (Malerba, 2002 and 2003).

Moreover, the complementariness that this approach offers concerning other different stances on innovation is particularly useful if we consider that the SSI perspective offers valuable elements to contextualise the relations and decisions that
agents (project owners and potential financiers in this particular case) get involved into and make when dealing with the financing of innovation. Indeed, we deem Malerba’s proposal a useful lens to examine and understand how innovation funding decisions are made because SSIs differ from and, simultaneously, complement other innovation views: it contemporaneously exhibits local, national and global dimensions, on one hand, and national innovation systems may also be driven by the dynamics of sector composition and interaction\textsuperscript{10}, on the other.

Furthermore, one of the most attractive characteristics of this analytical model has to do with the emphasis given to the dynamics of SSIs. In fact, the knowledge base (“the specific scientific and technological fields at the base of innovative activities in a sector”) and the technologies (“applications”) contribute to (re)define over time the boundaries of sectoral systems that are composed of heterogeneous actors. Yet, the type and dynamics of demand and the links and complementarities that exist among artifacts and activities also represent major factors in the “processes of transformation of sectoral systems”.

Moreover, the dynamics of sectoral systems are also affected by the institutions in which actors operate and relate to one another. Institutions, which may be sector-specific or national in character, “may emerge either as a result of deliberated planned decisions by firms or other organizations, or as the unpredicted consequence of agents’ interaction” (Malerba, 2005: p 394). As the author highlights, there is a chain-reaction effect that scales up from changes in the knowledge base and learning processes of individual organisations to deep behaviour and structure modifications of sectoral agents in terms of their relationships. Since the strategies and outcomes of individual enterprises, linked to national or international contexts, determine overall market competition and structure, firm reactions to changing environments trigger, in due turn, further changes in national and international scenarios\textsuperscript{11}.

Thus, the study of the financing of innovation under the lens of SSIs is justified by at least two related reasons: i) innovative projects are different across sectors (e.g., in

\textsuperscript{10} Malerba (2002 and 2005) emphasises that the dynamics and transformation of sectoral systems are based on the interplay of evolutionary processes that differ from sector to sector (e.g., variety creation, replication, and selection). “Change in sectoral systems are the results of coevolutionary processes in their various elements, involving knowledge, technology, actors, and institutions.”

\textsuperscript{11} A few short examples of particularly divergent sectoral dynamics over time (e.g., the pathway from pharmaceuticals to biopharmaceuticals or from integrated hardware/software developers to specialised software companies) are introduced by Malerba (2005) to illustrate the manner in which such processes vary extensively.
terms of uncertainty, risk, information asymmetry, costs, strategy) and have different effects and implications on the players’ interactions; ii) explanations and models of innovation funding should reflect such differences.

The bio-pharmaceutical sector, in particular, has been briefly characterised by Malerba (2003) himself as: i) a sector with a heavy influence of science (many different fields), networks, the division of innovative labour, universities, venture capital, and national health systems; ii) many types of actors participate in innovation: large firms, small firms, “new” biotech firms; iii) a sector where regulation, intellectual property rights, national health systems and demand impact innovation processes heavily; iv) common interactions include biotech firms competing/collaborating with and selling out to established large pharmaceutical firms; v) recent changes resulting in generic drugs opportunities; vi) firm “control” of a limited search space due to an expanding knowledge base that demands for strong interaction with other scientific institutions.

This picture was enhanced later when McKelvey et al. (2004) used the SSI lens to analyse the evolution of the European pharmaceutical industry by comparing the continental (Germany, France, Italy) and the Anglo-Saxon (UK and the USA) industry. Their work allows a more down-to-earth characterisation of the current reality of the industry by scrutinising the driving forces behind the paths made by different national SSIs within an increasingly global industry. Essentially, the authors recognise that the continental European bio-pharma model diverges from the Anglo-Saxon one (the USA and UK) because of some path-dependencies (e.g., the welfare state regarding the healthcare system, the regulation systems or the role of universities) that generated a different reaction, particularly, to the latest big issues in the sector: the biotech “revolution” (molecular biology) and the cost-containment trend (see also Scherer, 2010).

This has created some disadvantages in the European SSI, although it does not mean that the US system in particular is the best one (it displays its own contradictions and problems) and has to be imitated. It rather means that different SSI models exhibit their own specificities that need be taken into account to drive the sector modifications needed.
For instance, one of the current concerns, especially for the European bio-
pharmaceutical industry has to do with deficient investment in early stage projects,
which is related to a preference for late stage assets (which also occurs in the US)
that might cause the sector to weaken significantly in the near future when the flow
of assets in the development pipe reduce its value over time (Hellmann and Puri,
2000; Rosiello and Parris, 2009; UnicornBiologics, 2010; Haslam et al., 2011;
Hopkins et al., 2013). How could this be avoided? The simplest answer is by raising
larger new funds to support early stage research that generates new R&D projects.
This is the only way to sustain the delicate network within which innovative
companies operate to avoid financial distress that may seriously corrode and
obliterate the intangible asset base of the sector (Haslam et al., 2011). This becomes
a most unrelenting issue when the long-term orientation and the high costs of bio-
pharmaceutical R&D are considered (DiMasi and Grabowski, 2007).

Finally, a particularly relevant point made by McKelvey et al., (2004) has to do with
the fact that individual firm and industry behaviour in this sector is explained to a
great extent by actors, relationships and networks. Moreover, these three elements
are central to understand the importance of hands-on learning through networks
when knowledge in a given field is highly distributed and changes quickly, as is the
usual case in bio-pharma. In fact, Powell et al. (1996) assert that the key role that
networks play regarding innovation lies in the fact that networks both give access to
unavailable knowledge and other resources and also put internal expertise and
learning capabilities to the test. The peculiarities (dynamics, formality and
informality, pre-requisites, advantages and risks) of linking into a network in high
tech, and particularly in science-based industries, are detailed in the four hypotheses
formulated and successfully tested with data from the bio-pharmaceutical sector.

The authors feel that it is safe to conclude that learning effectively takes place within
a community of organisations of different types that exhibit a variety of
organisational practices instrumental in accessing the community (network).
Moreover, they find a path-dependent cycle of learning by which “an early choice of
exploration elicited positive feedback” (p. 142) and where gains include both
anticipated learning from specific projects, but also from unanticipated consequences
of involvement in the relationship given the serendipity of both science and
collaborations. So, the expanding connectivity in an expanding universe of
knowledge reveals two types of simultaneous and recursive learning: first, firms increasingly use ties “to enhance the inflow of specific information, resources and products” and, second, they become “more adept at and reputed for the general practice of collaboration with diverse partners” (p. 143). This is the basis of change in firm-level and industry-level practices that make their boundaries more permeable.

Complementarily, the triad actors-networks-relationships is also present in Powell et al.’s (2002) study of the peculiar relationships between “ideas and money” in the biopharmaceutical sector. The character of knowledge and the importance of institutional infrastructure to foster the transfer of such knowledge beyond spillovers seem to be two key elements to explain spatial clustering (of companies) and collocation (of VC funders and firms), in this industry in the US right since the beginning (Kenney, 1998).

Thus, we feel that this framework offers a relevant possibility to include an explanation on the funding of innovation in more comprehensive and pertinent terms. Whilst it does not explicitly incorporate the financing of innovation issue, it does offer a rich setting where our research questions (i.e., Who participates in the allocation or refusal of external funds to innovative projects in the biopharmaceutical sector (and science-based sectors in general)? How do the intervening players relate to each other and to their milieu in order to reach such decisions? Can the initiative of only one side successfully activate the financing mechanisms in science-based sectors?) can be set.

The SSI-based literature is certainly underdeveloped in terms of explaining the funding of innovation, but it fails in an entirely different way compared to the limitations present in the current attempts to explain innovation financing as explained in section 2.4; because the financial actors and processes are hinted at but are not included explicitly and comprehensively, they are not consequently used to bias the explanation in this view. The main issue with SSI-based explanations is, instead, the need to explicitly explore and define the roles of financiers and their systemic interaction with other agents in the framework of the bio-pharmaceutical (or any science-based) SSI.

Thus, our SSI-based analysis can help enrich and expand the SSI view by providing a broader landscape where essential but so far ignored actors (such as funders) play
relevant roles through the interaction with other players (e.g., firms and universities) in a wide variety of changing settings, and in a number of unsuspected manners in order to better explain how money and ideas come together.

The peculiarities of how that happens are still not well understood, as the problems of the extant literature discussed above suggest; nonetheless, we think that the analysis that we propose and develop hereinafter will contribute to enhance the general understanding of the financing of innovation (especially in science-based sectors) from the SSI perspective and, subsequently, to design proposals aimed at solving some of the most pressing problems in that area and under such a viewpoint.

2.6 Knowledge, access to knowledge, and SSIs

Knowledge has been deemed essential for the successful performance of firms (Nelson and Winter, 1982; Prahalad and Hamel, 1990; Kogut and Zander, 1992; Starbuck, 1992; Levinthal and March, 1993; Nonaka and Takeuchi, 1995), particularly if a firm’s core activities are essentially based on such knowledge as the case is with the so-called high tech and knowledge/science-based industries (Lundvall, 1993; Nelson, 1995; Dosi, 1997; Teece, 2001). Hence, the discussion of knowledge and learning (knowledge acquisition internally and externally) in organisations has become a multidisciplinary task that has given birth to a number of theoretical perspectives and a rich discussion about how knowledge is created, shared, used and stored in and by organisations (Dierkes et al., 2001).

Such, sometimes contrasting, perspectives have generated several proposed definitions of knowledge and learning. Malerba’s SSIs incorporate knowledge in the form of a base that includes all the knowledge underpinning the innovative activities of firms in a sector but which may be different in terms of its domain (both, “the scientific and technological fields at the base of the innovative activities in a sector” and its “applications, users and demand for sectoral products” (2002: p. 251)), and its degree of accessibility (internal and external) and cumulativeness; learning processes are a way to increase the cumulativeness of knowledge (the degree by which the generation of new knowledge builds upon current knowledge)

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12 Araujo (1998) and Dierkes et al., (2001), among others, provide an in-depth review and discussion of the multidisciplinary perspectives and proposals that are relevant to understand the many shades that underpin the different views existing on organisational knowledge and learning.
and are dependent on organisational capabilities (2002: p. 252). SSI’s references to knowledge and learning are clearly focused on the knowledge that production companies need and use to generate new products (innovators) in the context of certain technological regimes (ie., opportunity and appropriability conditions, degrees of cumulativeness of technological knowledge and characteristics of the relevant knowledge base (2002: p. 252)).

Nevertheless, for the purpose of this reflection we will start from one specific proposal that considers “knowing and learning as an inherently situated and distributed phenomena, residing in a series of non-localisable associations between social and material elements” (Araujo, 1998: p. 331); in other words, we essentially mean that learning (knowledge appropriation) is here conceived as something built inside a set of heterogeneous networks made up of social and material relationships and among different actors that go beyond and, even more, sidestep organisational boundaries as conventionally defined. This proposal seems particularly appealing because it brings together knowledge and its acquisition and makes them interdependent, firstly, and because it smoothens the transition from individuals to organisations, secondly (Levitt and March, 1990). And, we add, it seems also adequate to study the way in which potential funders and innovative venture owners, whatever their organisational form, interact. In this respect, and for this definition to be “operational” even at a theoretical level, it is also necessary to adopt an appropriate definition of organisations so that the features of these enable the smooth working of the former concept; consequently, we also adopt the proposal that Araujo puts forward where organisations are “collections of overlapping knowledge systems each of which may be embedded within a larger occupational community, rather than containers of knowledge and privileged locales of learning” (p. 331). Knowing and learning, thus, become a matter of knowledge systems interacting through the networking of individuals and organisations under different types of relations despite and beyond the existence of some conventional boundaries.

It is important to highlight that these concepts are chosen because they articulate with some ideas that have come to characterise knowledge. The classic distinction between objective and tacit knowledge, for instance, is particularly relevant because tacit knowledge is gained from experience, is difficult to communicate (codify), and is difficult to separate from knowledge creation and application itself, while
objective knowledge has been codified, which makes it easier to transfer under different conditions (Polanyi, 1962; Nelson and Winter, 1982; Nonaka, 1994). In fact, a dynamic and pluralistic epistemology of organisational knowledge can be defined by the relationships proposed between the explicit and implicit categories of individual and organisational knowledge (see Figure 1) where “[E]ach of the quadrants implies a different model of how knowledge, learning and memory interact... [since] firms cannot be understood as actualization of objective knowledge alone... and firms can know, learn, and store of all four types of knowledge.” (Spender, 1996: p. 71 and 73).

![Figure 1 – Matrix of relationships between types of organisational knowledge](image)

An important consequence of adopting the definitions mentioned above lies in the fact that knowing and learning become, thus, dependent not only on the internal workings of organisations and individuals, but on the networks within which organisations and individuals exist and operate (Spender, 1996; Araujo, 1998). In other words, networks turn out to be central for both accessing (chiefly external) knowledge and for developing innovation (a way of using knowledge) (Pittaway et al., 2004), particularly in knowledge/science-based industries.

It is not coincidental that the importance of networks for the creation, circulation, accumulation, and use of knowledge in organisations is also assumed in the context of the Sectoral Systems of Innovation (SSI) analysis, especially in what regards those interactions which are based on processes of communication, exchange, cooperation, competition and command among heterogeneous actors, and which specifically involve knowledge which is relevant for innovation and commercialisation (Malerba, 2002 and 2003). The importance allocated to acquiring knowledge (learning) through networks, in order for innovation outcomes to occur and be improved, lies in the fact that “[a] network serves as a locus of innovation because it provides timely access to knowledge and resources that are otherwise
unavailable, while also testing internal expertise and learning capabilities” (Powell et al., 1996: p. 119).

In other words, learning through networks has a powerful impact on the knowledge base (KB) of a particular SSI since knowledge is characterised by different degrees of accessibility (“opportunities of gaining knowledge that are external to firms”) and cumulativeness (“the degree by which the generation of new knowledge builds upon current knowledge”), and because the characteristics of any sectoral knowledge base are related “to the nature of knowledge underpinning firms’ innovative activities” in a given sector (Malerba, 2002).

The evolutionary underpinnings of SSIs underline the importance of certain cognitive dimensions (e.g., beliefs, objectives, expectations) that are impacted by previous learning and experience. Nonetheless, learning processes and the behaviour and capabilities of SSIs’ agents undergo, in turn, the restraints imposed by technology, the knowledge base and the institutional context of each milieu (Malerba, 2002). That is why knowledge and its acquisition play a fundamental role in the development of innovation (Nelson, 1995; Edquist, 1997; Dosi, 1997; Metcalfe, 1998).

In fact, the knowledge base differs across sectors because the particular science and technology fields involved in the innovative activities of distinct industries are diverse (Dosi, 1988; Nelson and Rosenberg, 1993) and because the applications, users, and demand for the products of each industry are also varied (Malerba, 2002). Moreover, the knowledge behind the innovations carried out in diverse sectors differs also in terms of specificity, tacitness, complementarity, and independence (Winter, 1987).

This is all visible in the particular case of the bio-pharmaceutical system of innovation (BP SSI), for example. The bio-pharma knowledge base is characterised as complex and ever expanding since the sources of expertise are widely dispersed and no individual firm or non-firm actor can exhibit mastery of more than a limited search space (usually a sub-space), so innovation heavily depends on the ability to interact with other actors to explore the whole search space (Powell et al., 1996; Malerba, 2003; McKelvey et al., 2004). Moreover, changes in the knowledge base of bio-pharma over time explain to a great extent the organisation of innovation-related
activities and relationships among actors in the sector, including their networking patterns in connection to the access to external knowledge (Liebeskind et al., 1996; Malerba, 2003), to the point that it can be stated that “actors, relationships and networks explain to a great extent individual firm and industry behaviour” in the bio-pharma space (McKelvey et al., 2004).

Thus, the SSI-based analysis, where knowledge and learning and their connections to networks play a central role (Powell and Brantley, 1992; Liebeskind et al., 1996; Powell et al., 1996), has in fact been useful to understand the dynamics of bio-pharma and has contributed an interesting view on the evolution of the industry, its drivers, components, structure, interactions and relationships, and trends of change (Liebeskind et al., 1996; Powell et al., 2002; Malerba, 2003; McKelvey et al., 2004). However, our analysis proposes to extend the scrutiny beyond the core of innovative companies in order to explain the role of the institutional setting and innovation financing.

Malerba’s (2003) initial characterisation of bio-pharma (biotechnology and pharmaceuticals), for instance, reviews the emergence of “new actors such as venture capital” (and the financial system in general) over time and incidentally points out at the role of public early stage investment in the construction of a solid knowledge base in the US, while a quick mention is made of the scarcity of R&D investment in Europe with the possible exception of the UK (Casper and Kettler, 2001; Hopkins et al., 2013). Nonetheless, no specific links and roles that regard the financing of innovation are depicted within the system.

McKelvey et al., (2004) partially fill the gap and establish a historical connection between the emergence of the “third epoch of bio-pharma” (the arrival of the molecular biology and cost-containment era) and the links that bind academia, property rights and venture capital in the US and its diffusion into other national environments (e.g., UK, Japan). The role of VCs is there described as having to do with financing potential academic entrepreneurs and providing them with managerial advice and organisational capabilities. In order to comply with such a function, VCs “… need not only strong specific and technical capabilities in finance, but also a deep knowledge of the science and the technology in which they are investing” (McKelvey et al., 2004). How they obtain such knowledge is, however, not delved into, beyond a passing mention of VCs and scientists’ common networks.
At any rate, an interesting triangle appears where innovation, knowledge/learning, and finance are apparently involved in a self-reinforcing relationship that deserves some reflection. As a matter of fact, in the existing literature on the external financing of bio-pharma innovation, venture capitalists of different sorts and business angels (VCs and BAs)\textsuperscript{13} are considered the main source of funding (Ullah et al., 2009; Haslam et al., 2011; Mina and Lahr, 2011; Bertoni and Tykvova, 2012) and, in partial coincidence with McKelvey et al., (2004), they are attributed two roles that support and complement their money supplying mission: they screen proposals in order to identify and pick up “the best projects” (Chan, 1983; Amit et al., 1998; Gompers and Lerner, 2001; Knockaert, Clarisse, and Wright, 2010; Bertoni et al., 2011) and help realise the potential of such projects by assisting their managers/organisations if they decide to throw money in (Gorman and Sahlman, 1989; MacMillan et al., 1989; Bygrave and Timmons, 1992; Sapienza, 1992; Barney and Busenitz, 1996; Sapienza et al., 1996; Kaplan and Strömberg, 2004; Bertoni et al., 2011).

Both such VC roles (scouting and coaching) involve the use of knowledge and intuition (Chan, 1983; Freeman and Soete, 1997; Amit et al., 1998; Zacharakis and Shephard, 2007; Yang et al., 2009) and entail different types of both experience (knowledge) and networking if success is to be expected (Yang et al., 2009). On the first issue (knowledge), even if some authors remark that the scouting and coaching functions are performed to a different extent according to the case and circumstances (Baum and Silverman, 2004; Engel and Keilbach, 2007; Colombo and Grilli, 2010), in general “VCs are viewed as knowledge reservoirs, coaches or certification providers” (Rosiello and Parris, 2009). Concerning the second issue (networks), most VCs and BAs commonly use networking with other investors as an investment strategy (syndication) (De Clercq and Dimov, 2008) given the main characteristics of bio-pharmaceutical innovation: fundamental uncertainty, higher risk, long-term horizon, prevailing asset intangibility, high cost (McKelvey et al., 2004).

In short, previous and new, internal and external knowledge seems to always be present in VCs’ strategic decisions and behaviour concerning their investment opportunities, their investees, and their co-investors (Norton and Tenenbaum, 1993; Yang et al., 2009; De Clercq and Dimov, 2008). Furthermore, in the co-investment
context, VCs and BAs need to develop knowledge of different types, at different levels, and from different sources if they want to accomplish their investment goals: they need the knowledge that will allow them to guide a particular company all the way from the initial investment to the successful exit, and the knowledge that will allow them to understand the decisions and processes involved in those activities (De Clercq and Dimov, 2008).

So the explanatory gap spotted and described above is even deeper concerning the nature, the role, and the effects of knowledge and networks among the external financiers of innovation in a sector (such as bio-pharma) where knowledge is at the very centre of the innovative activities of industrial companies and non-firm organisations (e.g., universities, government agencies). It is out of discussion that knowledge and money are essential for innovation and it seems reasonable to claim that knowledge about innovation is important for financing innovation in any given SSI. Yet, there is wide room for reflection regarding the relevance of and the links between knowledge and networks, as well as the implications of such relationship, in the case of VCs and other financiers that fund bio-pharmaceutical innovation.

Our reflection departs from the considerations established by the SSI view of bio-pharma. To begin with, learning is considered in the framework of a heterogeneous network of social and material relationships that go beyond traditional organisational boundaries (e.g., firms); next, it is essential to recall that the environment in which organisations operate (in the case of inter-organisational learning, for example) is made up of the same raw materials as organisations (mutating interactions and relationships), consequently it is more easily incorporated into the analysis when, for instance, organisational boundaries are hard to define (fuzzy borders) or when multiple inter-organisational interactions centred on knowledge/learning see one individual actor linked to different organisations in different ways as the fulcrum. Finally, knowing/learning in industrial settings usually depends on inter-organisational and institutional structures that may be formal (canonical) and informal (non-canonical) and attempts are usually made to render it (knowledge and learning) transferable and mobile as necessary (Araujo, 1998).

The heterogeneity and the varied and dynamic (changing) nature of actors and environments, the formality and informality of wide-ranging types of interactions and relationships, the varying levels of aggregation of individuals and organisations,
and the emergence and influence of institutions on the development of knowledge (knowing and learning) are structural constituents of SSIs (Malerba, 2002); thus, the base definitions adopted above seem conceptually coherent to be used in a robust explanation of how knowledge and networks are involved in the funding of innovation in an innovative science-based sector such as bio-pharma (Malerba, 2003; McKelvey et al., 2004).
3. METHODS

3.1 Introduction

Given the open nature and deep reach of the questions that underlie this research (namely, who makes, and how, the decisions about the allocation of external funds to innovative projects in the bio-pharmaceutical sector?), the methodological path of choice can only follow the specificities of a complex case study. The sources and the quality of the data needed to answer the queries posed strongly point towards a flexible and wide-reaching approach where information can be continuously interpreted and fed into the analytic framework in order to potentiate the explanatory capacity of the theory eventually proposed.

The structure of the chapter presents, then, two main parts. Section 2 will introduce the methodological framework selected to approach the research and will explain in detail all the relevant particulars regarding the sampling, collection, and analysis of primary data to be used in this study. Details of analysis are particularly remarked as they are very important to underpin the structure and explanatory substance of the findings that will, later, support the explanation proposed (theory building process).

Subsequently, Section 3 briefly complements the thematic analysis by formally displaying the summarised results of the theme coding process: the main themes, their underlying issues and the hierarchical relationships that turn them into a coherent body of evidence.

3.2 Methods

This section is made up of two sub-sections. Initially, we present a short characterisation of the framework applied, the data collection criteria and procedure, and the data obtained. Subsequently, a short explanation on the analytical process ensues.

a. Framework, collection, and data

To start with, the nature of the complex initial interaction between the two sides (investors and investees) of the innovation financing relationship requires some deep insight that can only be guaranteed by immersing into the phenomenon and gaining
knowledge from those that are familiar with the subtleties of the issues involved through their experience. Hence, a qualitative approach based on the case study of the sector of interest is the choice for this study.

It is deemed the most appropriate line of attack for three reasons: i) this subject cannot be undertaken on the basis of exclusively quantitative information as previous studies suggest (e.g., Haslam et al., 2011); ii) a sectoral case study is suitable to the complexity of the topic that involves different actors, issues, factors, and subtleties regarding their interactions in a characteristic environment; moreover, studying the processes that underlie the strategic decisions that regard financing innovation is easier if done in a context where theoretical concepts, constructs and categories are neatly defined in relation to ‘reality’; iii) case studies also allow the flexibility required to continuously incorporate feedback into the theoretical analysis of the phenomenon studied and facilitate the iterative process of building up/enhancing explanations (Hakim, 1987; Eisendhardt and Graebner, 2007; Yin, 2009).

As such, this methodological approach is in line with the need expressed in the literature to accumulate case studies in order to understand: i) the way in which the financial strategy is linked to other strategic decisions made by those who control resource allocation within and outside a company; ii) the integration into organisations of the available capability mix embodied by people and the way in which learning processes are organised around individuals, organisations, and institutions; iii) the supply-and-demand relations and interactions that shape strategic funding decisions regarding innovation (O'Sullivan, 1998; O’Brien, 2003; Casson et al., 2008; Atherton, 2009). Finally, the sector-based case study is used to build theory, not to test it, in accordance with the principle that “cases are selected because they are particularly suitable for illuminating and extending relationships and logic among constructs” (Eisenhardt and Graebner, 2007).

Thus, the primary data collection for the case research on the funding of the biopharmaceutical sector is primarily supported by a series of semi-structured interviews (Figure 2) conducted with thirty participants that have played different roles as senior managers from different organisations of the bio-pharmaceutical sector (e.g., firms, universities, science parks, incubators) and highly experienced VC practitioners that have worked for a wide variety of organisations that fund biopharmaceutical innovation (gap VC funds, generalist VC funds, specialised VC
funds, market-making/advisory). We will come back to this later in order to explain in further detail the rich and wide experience of the interviewees and its important implications to build an explanation around the questions proposed.

The bio-pharmaceutical sector was chosen because it exhibits an amazing complexity related to the heterogeneity embodied by a multifaceted network of players (from universities and research centres, to a range of variously-sized companies, to a multiplicity of potential financiers, regulation bodies and national/regional government agencies included), to the nature and development path of innovative projects, and to the assorted competitive and collaborative interactions framed in a particular setting with well-defined specificities (see Chapter 2) (O’Brien, 2003; McKelvey et al., 2004; Rosiello and Parris, 2009; UnicornBiologics, 2010; Haslam et al., 2011).

The interviewees were selected on the basis of two criteria: i) their experience in and knowledge about firm and non-firm organisations in the bio-pharmaceutical sector and related VC organisations, ii) their relatively senior positions so that they have decision-making power about funding projects or have a wider view regarding the whole sector and its sub-sectors concerning the funding of innovation.
Semi-structured interviews (see Appendix for interview guides) are considered the appropriate tool to obtain primary data because they allow an agenda shaped around the research questions, but open-ended and flexible enough (Alexiadou, 2001) to accommodate the wide variety of relevant experience that the participants and the organisations they have worked for exhibit. Such a feature is essential given the base definitions of knowledge/learning and organisations adopted (see Chapter 2 on Literature Review and Theoretical Framework) and the peculiarities that they imply: blurred organisational borders, heterogeneous network partners, mixed (formal and informal) and mutating interactions and relationships.

Elite semi-structured interviews are, in fact, useful to deeply explore complex case studies because they can provide, through answers to open-ended questions, appropriate levels of detail, depth and insiders’ perspective (Berry, 2002; Leech, 2002). Elite semi-structured interviews facilitate the contact and “tuning in” process between the researcher and the interviewee, enable double-checking particular data details, allow to ask hard/sensitive questions in a broader and more relaxed context, and consent to the use of specific landmark comments of the interviewee to navigate further and deeper into the topics of interest as long as they are linked to the interviewees’ experience and according to the purpose set by the researcher (Aberbach and Rockman, 2002).

The individuals interviewed, in fact, have their own personal stories (e.g., educational and professional background, experience, acquaintances and friends) and, simultaneously, are a part of (then, know at least partially) the stories of the different organisations they have worked for and of the sectors and sub-sectors they work in. This is the basis of their expertise concerning the topic of our interest. Thus, the semi-structured interviews facilitate the “navigation” of their expertise, its building process (experience), and the way in which these are used in context (e.g., roles held in organisations, agencies, projects) to make decisions about and reflect upon the funding of innovation. Such an insight is essential to build up an SSI-based view of our focal phenomena where knowledge, learning and networks are a key building block (Powell, 1996; Malerba, 2002; McKelvey et al., 2004).

In terms of the procedure, the selection was done by initially cold contacting more than one hundred experts known to be strongly linked to bio-pharma in the UK, continental Europe and the US so that some of the countries where the bio-
pharmaceutical sector is strongest are included (UnicornBiologics, 2010). Most of the contacts were made through e-mail messages and ensuing telephone calls (not always replied). Since cold contact with these persons is difficult due to the nature and restrictions of their positions\(^{14}\), the acceptance rate is usually very low. However, at some point, when a first contact proved successful, the snowball technique was found very useful to contact other potential interviewees because of the tight networking existing among them (an *ex ante* indicator of the importance and value of networks in the bio-pharmaceutical sector).

All the interviewees have, then, relevant experience in the making of deals aimed at funding innovative projects in the bio-pharmaceutical sector and some of them have also been or are currently related to non-corporate organisations linked to the sector such as, for instance, associations in the biotech industry, science parks, incubators, national research agencies, and university science hubs (see Table 6).

The interviews (most of them were audio-recorded and supported by researcher’s notes) were centred on the way in which contact among project owners and prospective external financiers are established and investment terms are negotiated. In some cases, follow-up communication was used to clarify or go deeper into issues of particular relevance that raised further questions from the researcher. Primary information is complemented, when necessary, with secondary data coming particularly from studies and reports on bio-pharma and about innovation financing in the sector (e.g., European Commission – Enterprise and Industry, 2009; UnicornBiologics, 2010; Department for Business, Innovation and Skills (BIS), 2010; Ernst and Young, 2013; Citeline, 2013) and, where available, information about some of the organisations for which the interviewees have worked; this permits the triangulation of information (when possible), the contrasting of perspectives, and the integration of a rich perspective on the shades that characterise the experience of different actors in the sector.

The data about the informants, the organisations they have been or are currently related with, and other relevant details have been anonymised at the request of the interviewees in order to avoid potentially undue revelation of information.

\(^{14}\) Securing access to the interviewee is usually the first and one of the hardest problems that any researcher conducting elite interviews faces (Aberbach and Rockman, 2002; Goldstein, 2002).
### Table 6 – Basic details of interviewees for the bio-pharma case study

<table>
<thead>
<tr>
<th>INTERVIEWEE</th>
<th>RELEVANT EXPERIENCE</th>
<th>CURRENT ORGANISATION</th>
<th>PRESENT ROLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Training in life sciences. Over 30 years international experience in the pharmaceutical &amp; chemical industries, including recent roles as a Chairman and CEO</td>
<td>BP company</td>
<td>CEO</td>
</tr>
<tr>
<td>12</td>
<td>Training in business. Over 20 years in big bio-pharma companies and SMEs, and investment funds in non-executive and CEO positions</td>
<td>BP company</td>
<td>CEO</td>
</tr>
<tr>
<td>13</td>
<td>Training in life sciences. Over 10 years as senior scientific manager, entrepreneur and CEO (founder of university spin-out based on his own research and IP)</td>
<td>BP company</td>
<td>CSO</td>
</tr>
<tr>
<td>14</td>
<td>Training in life sciences. Over 20 years as entrepreneur and CEO. Founder or three different companies in Europe and the US</td>
<td>BP company</td>
<td>CEO</td>
</tr>
<tr>
<td>15</td>
<td>Training in life sciences. Over 8 years in biotech as company fund raiser and innovation manager for stratified medicine teams from Medical Technologies, Health Services, and Pharmaceutical and Biopharmaceutical Hubs</td>
<td>Stratified Medicine University Hub</td>
<td>Innovation Manager</td>
</tr>
<tr>
<td>16</td>
<td>Training in law and international relations. Over 5 years in parliamentary research and Biotech Industry Association</td>
<td>Biotech Industry Association</td>
<td>Head of Public Affairs and Policy</td>
</tr>
<tr>
<td>17</td>
<td>Training in life sciences and engineering. Over 8 years in roles facilitating biomedical companies access to market, money, skills and technology and as innovation network leader.</td>
<td>Science and Innovation Campus</td>
<td>Business Development Manager</td>
</tr>
<tr>
<td>18</td>
<td>Training in politics, philosophy and economics. Over 8 years in VC industry, different types of funds, founding director, board member and observer, and advisor</td>
<td>Private generalist VC fund - National scope</td>
<td>Investment Director</td>
</tr>
<tr>
<td>19</td>
<td>Training in economics and business. Over 10 years in VC industry, different types of funds</td>
<td>Private generalist VC fund - Regional scope</td>
<td>Investment Director - Equity</td>
</tr>
<tr>
<td>20</td>
<td>Training in life sciences and business. Over 10 years in VC industry, different types of funds</td>
<td>Public specialised gap VC fund - Regional scope</td>
<td>Senior Investment Director</td>
</tr>
<tr>
<td>21</td>
<td>Training in life sciences. Over 10 years in VC industry, different types of funds - Advisor to would-be investees, client development and biotech R&amp;D</td>
<td>Institutional Fund Raiser - National scope</td>
<td>Fund Founder, Fund Raiser and Advisor</td>
</tr>
<tr>
<td>22</td>
<td>Training in life sciences and business. Over 16 years in VC industry, different types of funds</td>
<td>Publicly quoted specialised VC fund - International scope</td>
<td>Healthcare Ventures Managing Director</td>
</tr>
<tr>
<td>23</td>
<td>Training in life sciences. Over 12 years in VC industry, different types of funds, companies and positions</td>
<td>Specialised VC fund – International scope</td>
<td>Investment Director</td>
</tr>
<tr>
<td>24</td>
<td>Training in life sciences. Over 25 years in VC industry and different types of bio-pharma companies (R&amp;D) and university positions (professor, chairman, pro-dean)</td>
<td>Specialised VC fund – International scope</td>
<td>Biotech Venture Partner</td>
</tr>
<tr>
<td>25</td>
<td>Training in life sciences. Over 20 years in VC industry and different types of bio-pharma companies (co-founder and CEO) and university positions</td>
<td>Specialised VC fund – International scope</td>
<td>Senior Partner</td>
</tr>
<tr>
<td>26</td>
<td>Training in life sciences. Over 10 years in bio-pharma companies as entrepreneur and manager, and incubator consultant</td>
<td>BP company and Incubator</td>
<td>Manager, Incubator Consultant</td>
</tr>
<tr>
<td>27</td>
<td>Training in business. Over 10 years in bio-pharma companies as entrepreneur and</td>
<td>BP company</td>
<td>Managing Director</td>
</tr>
<tr>
<td>Number</td>
<td>Training and Experience</td>
<td>Position Details</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>118</td>
<td>Training in engineering, sciences and life sciences. Over 10 years in VC funds and healthcare companies as technology investment and commercialisation director</td>
<td>Specialised VC fund – International scope</td>
<td>Life Sciences Business Development Director</td>
</tr>
<tr>
<td>119</td>
<td>Training in business. Over 18 years in biotech-related positions and VC industry</td>
<td>Publicly quoted specialised VC fund - International scope</td>
<td>Biosciences Ventures Director</td>
</tr>
<tr>
<td>120</td>
<td>Training in life sciences. Over 10 years in biotech-related positions</td>
<td>Public body supporting bioscience research</td>
<td>Senior Innovation Manager</td>
</tr>
<tr>
<td>121</td>
<td>Training in life sciences. Over 15 years in small and large biotech companies and over 4 years as VC investment manager</td>
<td>Specialised VC fund – International scope</td>
<td>Managing Investment Director</td>
</tr>
<tr>
<td>122</td>
<td>Training in life sciences and business. Over 20 years in financial management consulting, international business development for big pharma, spin-out incubator head, and fund manager</td>
<td>Specialised VC fund – University spin-outs scope</td>
<td>VC Fund Manager</td>
</tr>
<tr>
<td>123</td>
<td>Training in life sciences and business. Over 15 years in business development and VC investing</td>
<td>Specialised VC fund – International scope</td>
<td>VC Investment Manager</td>
</tr>
<tr>
<td>124</td>
<td>Training in life sciences. Over 30 years in business development and licensing and as CEO for biotech companies, and M&amp;As and VC deal-making and investment</td>
<td>Specialised VC fund – International scope</td>
<td>VC Investment Manager</td>
</tr>
<tr>
<td>125</td>
<td>Training in Law and Religious History. Over 30 years in pharma corporate VC, as biotech spin-out founder and CEO and specialised VC funding</td>
<td>Specialised VC fund – International scope</td>
<td>VC Investment Manager</td>
</tr>
<tr>
<td>126</td>
<td>Training in life sciences and business. Over 15 years in biotech R&amp;D, business development, and VC funding</td>
<td>Specialised VC fund – University spin-outs scope</td>
<td>VC Investment Manager</td>
</tr>
<tr>
<td>127</td>
<td>Training in life sciences. Over 20 years in biotech R&amp;D, entrepreneurship, licensing and business development, and VC funding</td>
<td>Biotech Spin-Out Company</td>
<td>Licensing &amp; Business Development Entrepreneur and CEO</td>
</tr>
<tr>
<td>128</td>
<td>Training in life sciences. Over 30 years as bio-pharma R&amp;D, international business development, small biotech entrepreneur and CEO</td>
<td>BP company</td>
<td>CEO</td>
</tr>
<tr>
<td>129</td>
<td>Training in life sciences. Over 20 years in public market funding, entrepreneurship and CEO leading</td>
<td>BP company</td>
<td>CEO</td>
</tr>
<tr>
<td>130</td>
<td>Training in life sciences. Over 20 years in biotech R&amp;D, licensing, entrepreneurship and CEO leading</td>
<td>BP company</td>
<td>President and CEO</td>
</tr>
</tbody>
</table>

Source: Author’s own elaboration

As a result of the semi-structured interviews, a corpus of testimonial data was obtained that ranges from personal background and experience, and detailed information about specific investment cases, to general appreciations on the historical evolution of the funding activity in the bio-pharmaceutical industry, to personal views about the prospective development of investment and its main factors in the sector of interest.
On a related account, a particular issue that needs to be remarked about the interviewees is that most of them, if not all, have a rather extensive track record of experience in more than one organisation and position, as well as in different types of organisations. What we intend to say is that although there is no theoretically established fixed parameter for a given number of participants/informants in the framework of a case study, the sample of thirty interviewees we have built here is really richer than it appears because of four reasons:

i) Most of the interviewees have worked for more than one organisation (some have even worked for five or more) along their professional life;

ii) Most of the interviewees have also worked for different types of organisations along their professional lives (e.g., small, mid-sized and big, young or seasoned bio-pharmas, state and privately owned companies and venture capital funds which may be specialised or generalists and that invest nationally or internationally);

iii) Most of the interviewees have also worked in different positions from university or corporate researchers to entrepreneurs and CEOs/CSOs to VC investment managers company board members and, in some cases, they do it simultaneously because their professional roles require so.

iv) The interviewees are located in four different countries (the United Kingdom, the United States, Denmark and France), but their experience includes many other European and American countries as most of them have worked for organisations located or operating also in other “geographical jurisdictions” (e.g., Sweden, Finland, Norway, Spain, Germany, Canada) where bio-pharma is present and important.

Moreover, the interviewees currently play senior managing roles in a variety of organisations that illustrate the variety of sectoral organisational actors and can be distinctly characterised as follows: ten bio-pharma companies of different size and age, fifteen venture capital funds (out of which two are generalist and the others are specialised funds; one is a public fund; two funds invest regionally, four invest nationally (two of them finance university spin-outs specifically) and the others internationally; only two specialised international investors are publicly quoted); and
the remaining five are public or private meso-level organisations that support (fund raising included) either specifically innovators/entrepreneurs (e.g., a university hub where different but related knowledge areas linked to stratified medicine articulate their research efforts, and a science/innovation campus) or most sectoral actors in general (an industry association, a national research support body, and an institutional fund raiser) (see Table 6).

If the former roles of the interviewees in different other organisations and their professional training and further experience (that broadly cover positions such as non-executive board member, researcher, entrepreneur, fund-raiser, contact facilitator and match-maker for start-ups and potential funders, advisor to investors and investees, observer, university professor and dean, incubator consultant and head, technology investment director, business development head, licensing director) are taken into consideration, it is clear that the knowledge built and disseminated through their movements across organisations and their changes of roles in the context of a network of sectoral actors, these individuals embody a rich story which is not usually taken into account and used to explain the dynamics of the sector.

Finally, it is also worth highlighting that whilst it is true that most of the organisations are private (except for a university hub, a gap venture fund, a fund raiser, and a research support body), the persons interviewed, and possibly many others in several different roles, have mostly also built up extensive experience in private sector organisations, mostly bio-pharma companies; however, the reverse is also true as many professors/researchers in this sector move from public universities to private companies, for example, though this tends to vary in accordance with the context. Thus, this is a testimonial to the exchange of knowledge and experience that characterises the whole sectoral networking tissue.

A couple of examples may help make it clear. In one case, for instance, the person interviewed has successively been a university professor and researcher, an entrepreneur (founder of at least one start up based on his own research), a manager (in his own or another company), and a VC consultant or investor. Also, there is the case of a VC investment manager that sits in three or four boards at the same time as executive or non-executive member as a part of his investment commitment. This is the case with most of our interviewees.
What this implies in terms of their experience and the knowledge they have accumulated is that if one wants to measure the sample in terms of interviewees, certainly we are talking about thirty people. But, if one refers to the experience and the knowledge gathered by these individuals through different organisations and roles (professional figures), one can easily be talking about a huge number of differentiated, though often combined, roles that go from researcher/entrepreneur to multiple investor/board member to entrepreneur/manager to former researcher/entrepreneur turned to investor/board member and consultant/advisor; moreover, most of these individuals often boast some deep and widely varied knowledge deriving from long-time mixed experiences that include an extensive assortment of knowledge areas undertaken through training or practice (see Table 6). What we mean is that the impressive track record of most of the interviewees only adds up to the complexity that underpins the behaviour, interactions and relations among the different actors that play different but relevant roles in the funding-related activities of the biopharmaceutical sector across the world.

b. Analysis process

The main stages of the analysis presented includes: i) listening and transcription of individual interviews; ii) deconstruction of individual interview transcript data into blocks of information focused on seven main issues; iii) construction of an issue-based matrix through analytical comparison of transcript blocks (data reduction) that takes account of similarities and differences in the experience and views of the participants; iv) re-creation of a narrative based on the data transcripts with reference to the main issues (sense-making structuring); v) interpretation of findings and elaboration of theoretical proposal (dialogue with theoretical framework) (Miles and Huberman, 1994; Braun and Clarke, 2006).

The first two stages were done by paying scrupulous attention to the contents (McLellan et al., 2003) related to seven particular issues: i) knowledge about the sector (bio-pharma); ii) networking matters; iii) interactions; iv) availability of funding sources and mechanisms; v) funding of stages; vi) trends of change; vii) other relevant issues (a sort of residually significant category of information) (Aberbach and Rockman, 2002; McLellan et al., 2003; Braun and Clarke, 2006).
The passage from the “raw” interview transcripts to the issue-based matrix was mainly done by coding manifest items, initially, and latent and global items, later on. The first type of item refers to specifically direct answers to particular questions; this kind of answers regarded, for example, questions about spotting investment or funding opportunities (according to the question being posed to either potential investors or project owners) (e.g., How do you get to know about potentially interesting investment opportunities in the bio-pharmaceutical sector? / How and where do you look for and contact potential external funders?) (see Appendix 3). Latent items, in turn, come up not from the answers elicited by the questions directly but, sometimes, from some of the prompts that complemented the questions or, some other times, from the “navigation process” that ensues a question whereby an interviewee brought about a topic initially not considered for explicit interrogation (e.g., several interviewees called to mind their specific experience in certain roles and organisations in order to explain how certain networking mechanisms worked for them in a particular situation which may not be a general case). Finally, global items refer to judgments formed by the coder based on the interview transcripts about “general traits and styles”. This is, for instance, the case of some investors’ characteristics; there was no specific question about the traits of financiers other than a general classification (i.e., government agencies, banks, other companies, specialised investors, non-specialised investors) presented to company managers. However, most firm managers, VC investment managers and other interviewees contributed here and there a number of statements concerning this particular item that could later be consolidated into a proper category during data reduction (Aberbach and Rockman, 2002).

Now, these three types of coding items fed the data reduction process directly because they constitute the basis for the definition of the thematic analysis and the arrangement of these into a self-supporting hierarchical structure (see Figure 7). That is how the direct responses to the questions about the investing/funding opportunity spotting activity (Figure 3) underpins the emergence of financiers’ reactiveness or proactiveness codes (Figure 5) that will, later on, facilitate and explain the creation of two theoretical constructs (“selection” and “learning and shaping” – Figure 6) that will, in turn, support the theoretical explanation proposed in Chapter 5. Something similar happens with all the other code types; latent codes about contacting other
players (networking) and global codes about the origin of the investment funds or the investment time horizon, for instance, (Figure 3) remit to topics such as knowledge about science and technology or market of an industry and to stand-alone or co-investment (Figure 5) which, in turn, underlie theoretical constructs such as the Investors’ Knowledge Consolidation System (IKCS) (Figure 6). Thus, the coding process based on the interview transcripts enables a rather smooth data extraction and passage into thematic analysis as explained hereinafter (Aberbach and Rockman, 2002; Braun and Clarke, 2006).

The third stage (data reduction) was done through human means (no resource to computer-aid processing) in order to preserve some potentially important characteristics of the data obtained (e.g., the possibility of meaning ambiguity, interpretive ambivalence of some replies or particular terms within such answers, or emphatic speech) that may contribute to the depth of the reconstitution and analysis of the narrative.

The data reduction procedure, in particular, is based on the application of thematic analysis, a widely used qualitative analytic method. It is particularly useful to identify, analyse and report patterns (i.e., themes) within data and it, therefore, has the potential to provide “a rich and detailed, yet complex account of data… [since it works] both to reflect reality and to unpick or unravel the surface of ‘reality’” (Braun and Clarke, 2006: p. 78 and 81).

In this case, theme identification is inductive or “bottom up”, which means that the patterns emerge from the data collected through the elite semi-structured interviews and is consistent with a constructivist epistemology that “seeks to theorize the socio-cultural contexts, and structural conditions, that enable the individual accounts that are provided” (Braun and Clarke, 2006: p. 85). This procedure fits well the approach of different levels of questions (a-the research questions; b-the questions posed to the interviewees; c-the questions that guide data coding and analysis) that are usually present in qualitative research and in case studies such as this one (Braun and Clarke, 2006).

The steps of the data reduction process are, accordingly, explained and illustrated as follows. To begin with, specifically relevant contents of the issue-based matrix give keys to structure a framework of closely related topics covered in the interviews.
Content-based topics are deemed pertinent because they contribute different elements to attempt an answer to the questions posed. They are, consequently, used to set up a framework of the main issues emerging from the interview (Figure 3) and are, subsequently, graphically related by means of a clustering exercise that shows a loose pattern of relationships ordered around two central and interrelated matters (hubs in the cluster map): the investors’ understanding of innovative projects and their links with contacts that exhibit, in turn, appropriate knowledge about such projects (Figure 4).

Afterwards, the cluster items are superimposed to the issue-based interview framework by using different higher-category labels that subsume the nature of the different cluster items. For example, company managers and investors were asked if they actively looked for the other party (managers looking for funding/investors spotting projects for investment) or just waited for that party to come forward; if the first was true, they were inquired about who they usually contacted; both managers and investors replied that they mostly contacted people/companies they had already had a relation with. In such a case, former contacts between funders and fundees or even among different funders (“long-time relationship” and “fellow investor” in Figure 4) are included both under the label “known” and the label “co-investment” (specifically for investors) in the emerging issues graph (Figure 5).

The fourth stage (sense-making structuring) was carried out in order to articulate the participants’ multiple views into a coherent, yet shade-rich narrative that presents the leading ideas and the contrasting perspectives in such a manner that the outcomes based on the heterogeneity of actors, surrounding conditions, and trends of change do not convey the idea of stark contradiction, but rather of rich variety that is characteristic of the sector reality and the SSI-based theoretical view. This stage is summarily represented by associating the emerging issues graph (higher-category labels allocated previously) with the main constructs proposed to generate the explanation under construction (Figure 6).

Turning to the illustrative example above, the labels “known” and “co-investment” are associated with the construct “networking” and “lead/co-lead investor” that are then used to help build up the explanation on how certain decisions on the funding of innovative projects in the bio-pharmaceutical industry are strongly influenced by earlier successful relations between two or more parties (Figure 6).
Entrepreneur/Management looking for funding

Contacting potential funders

Info requested

Investors (VCs) locating investment opportunities

Criteria to allocate/deny funding

Interest in project/company

Preferred stage for investment

Preferred mode and time of exit

Average investment time horizon

Preferred investment structure

Context
(Sector / Country)

Source: Author’s own elaboration
Investors’ understanding of projects
(Science, technology, markets, …)

Knowledge level
(specific/detailed/deep)

Complexity level

Changing environment

Ex-CEOs
Ex/Scientists
Entrepreneurs
Academics

Knowledge level
(specific/vertical)

Enthusiasm about science

University
TTOs &
commercial
arms

Ex/Scientists
Entrepreneurs
Academics

Investment size & term commitment

Investment base

Timing
(in & out)

Exit type

Info access

IPR

Investment/disinvestment decisions

Financial
technical knowledge

Prior sector of investment

Strategic expectations

Geographic scope

Due diligence

Team assessment / value

Technology assessment / value

Successful prior investment

Sitting on Boards of Directors

Valuation of macro-climate

Sector changing trends

Sitting on Boards of Directors

Reputation (trust)

Government investment

Long-time relationship
(personal /)

Co-investment

Fellow investors

“Valuation, more art
than science… more luck than judgement”

“Uncertainty & project stage”

The earlier the stage,
the more a finger in the
air it is

Due diligence

Investment size & term commitment

Investment base

Contacts with appropriate knowledge

Figure 4 – Cluster Map
Source: Author’s own elaboration
Source: Author’s own elaboration
Figure 6 - Theoretical Constructs

Source: Author's own elaboration
The last stage (dialogue with theoretical framework) is centred in analytically incorporating the main findings around the topics of concern into a coherent explanation aimed at enhancing and enriching the theory about the strategic role that knowledge and networks play in the funding of innovation with particular reference to the bio-pharmaceutical sector.

Figures 3 to 6 illustrate the coherence of the passage from the overall research questions, all the way through the questions formulated during the semi-structured interviews, and finally to the questions that guided the coding of the data into themes and their subsequent analysis.

The emerging themes are arranged into a self-supporting layout (Figure 7) which means that the bottom two levels are key to define the top three levels and, in turn, the middle level (availability of funding sources/mechanisms and stage funding readiness) is essential to determine the interactions that make networking and knowledge acquisition possible. Ultimately, the hierarchical arrangement of themes and their relationships create and sustain variety in the different decisions involved in the funding of an innovative project. This is important to remark because, as we shall see, these decisions do not imply a simple yes/no dilemma and have long-term meaning and effects on the projects and companies involved.

![Figure 7 – Arrangement of Main Themes](source: Author’s own elaboration)
To further illustrate the data reduction process by means of thematic analysis, a series of graphs are displayed (see Figures 8 to 14) that show additional details emerging from the interviewees’ answers to the questions on the main topics of interest concerning the funding of innovation in the bio-pharmaceutical sector (see Appendix 3). Figures 8 to 14 constitute a more fine-grained view of the hierarchical arrangement of the themes ranked in Figure 7.

As a matter of fact, whilst they provide further details on the sub-topics and their relatedness standing (first or second order according to the continuous or the dotted line used in the graph to connect them to one of the central themes or among themselves), they also illustrate some relevant connections among the central themes structured in Figure 7. For example, in Figure 8 that represents the theme coded as “Knowledge of Sector”, “active search” is a first order term that ties the said theme to the “Networking” theme (Figure 9). But such a link is also established in Figure 8 by a second order term (“mentors”) that is associated to a first order one (“track record”).

Similarly, “Networking” as a theme can be linked to “Knowledge of Sector” through first order terms such as “formal mechanisms” or “actors/players” and through second order terms such as “assessment” tied to first order ones (“track record”) in Figure 9. Just the same can be said of the remaining five graphs (Figures 10 to 14).

Thus, the collection of figures presented should be considered as a zoom-in view of a general map (Figure 6) that describes the hierarchical arrangement of the main themes that emerge from the interviews in connection to a set of constructs that will be used later to proceed into the last part of the analysis and the proposal components of the methodological design (Figure 2). As such, the zoom in / zoom out map versions will guide the re-creation of the narrative based on the interview transcripts that will thus allow us to “make sense” of the data collected (see Chapter 4) and to interpret such findings in order to establish a dialogue with the theoretical framework proposed so that an explanation can be developed on the funding of innovation in a given sector. Thus, we expect that this sectoral case study will, using Eisenhardt and Graebner’s (2007) words, illuminate and extend the logic and relationship of the constructs that underlie the proposal advanced in Chapter 5.
Figure 8 – Emerging themes: Knowledge of sector
Source: Author’s own elaboration
Figure 9 – Emerging themes: Networking
Source: Author’s own elaboration
Figure 10 – Emerging themes: Interactions
Source: Author’s own elaboration
Figure 11 – Emerging themes: Funding sources and mechanisms available

Source: Author’s own elaboration
Figure 12 – Emerging themes: Readiness to fund different venture stages
Source: Author’s own elaboration
Figure 13 – Emerging themes: Characteristics of investors

Investor Characteristics

Sources of funding & team size

Profit/Risk profile

“Pocket depth”

Investment events

Co-invest

Stand alone

Co-lead

Follow

Lead

Follow on

Patience

One-off

Preferred stage for investment

Geographic distance

Very early

Early

Late

Trade sales

Licensing

Mergers and Acquisitions

IPOs

General stock markets

Technological stock markets

Preferred mode of exit

Timing

Investment time

Investment structure

Strategic goals

Technological stock markets

“Knowledge about sector”

Very early

Early

Late

“Knowledge about sector”

Trade sales

Licensing

Mergers and Acquisitions

IPOs

General stock markets

Technological stock markets

Profit/Risk profile

“Pocket depth”

Investment events

Co-invest

Stand alone

Co-lead

Follow

Lead

Follow on

Patience

One-off

Preferred stage for investment

Geographic distance

Very early

Early

Late

Trade sales

Licensing

Merges and Acquisitions

IPOs

General stock markets

Technological stock markets

Figure 13 – Emerging themes: Characteristics of investors

Source: Author’s own elaboration
Figure 14 – Emerging themes: Trends of change
Source: Author’s own elaboration

- Trends of Change
  - Charity involvement in funding
  - Corporate VC rush to fund early stage
  - Scarcity of VC early stage funding
  - Meaning of “Early stage”
  - Strategic reasons
  - Financial reasons
  - Replenishing pipeline
  - Scaling back R&D
  - Shortening investment time horizon
  - IPRs
  - A battery of tests
  - Personalised therapies
  - Cost/Return
  - Stratified Medicine
  - Competition for funding
  - ... Networking
  - ... Funding sources/mechanisms available
  - Mixed Funding (State-Private)

... Knowledge about sector

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Figures 7 to 14 want to illustrate, then, the cohesiveness and consistency of the themes identified (thematic analysis) and the width and plausible level of detail analysis that the themes reported can be subjected to so they can help support a theoretical explanation on the relevant issue at study.

3.3 The process behind the findings

This section briefly illustrates the passage from the raw data to the analytic results and, later, to the proposal that we discuss so that the mechanisms which underlie our theoretical arguments are clear.

Thus, starting from the bulk of raw interview contents, a search for data patterns (thematic analysis) was performed. Firstly, the answers provided by the interviewees to the semi-structured interview questions posed in each case have been classified around seven main emerging issues, namely: i) knowledge about the sector (where investments are made); ii) networking matters; iii) interactions (among players); iv) availability of funding sources and mechanisms; v) funding of stages; vi) characteristics of the investors; vii) trends of change in the sector. Additionally, a sort of significant category of residual information was defined to include other potentially relevant issues.

All these issues refer, of course, to the bio-pharmaceutical sector and come up from the experience of the interviewees in different roles, in different types of organisations, and under different circumstances, but are all related to the main enquiry: How are investment decisions about innovative projects reached? Who participates and how?

In order to attempt an answer to these questions, it is necessary to acknowledge that the identification of the themes listed above is based on the outstanding pertinence of certain elements contained in the responses of the interviewees. The themes were initially identified and then went through a process of “hierarchisation” which is not easily seen from the outside, but whose pattern can be observed and understood thanks to the background understanding of the sector and the players’ roles (i.e., existing literature) and to the contextualisation of the conversation topics during the interviews. Of course, this all takes place in the light of the theoretical lens we chose to approach the analysis of the financing of innovation in a specific sector. Thus, the
thematic analysis allows us to build up a structured layout where the issues are arranged according to levels of relevance and supporting relationships.

Table 7 – Identification of Main Themes

<table>
<thead>
<tr>
<th>THEMES</th>
<th>UNDERLYING INTERVIEW ISSUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about sector</td>
<td>Understanding science and technology behind the project&lt;br&gt;Knowledge about the sector R&amp;D processes&lt;br&gt;Knowledge about the product market and sector in general (e.g., competitors, regulation, IPRs)&lt;br&gt;Sectoral expertise</td>
</tr>
<tr>
<td>Networking</td>
<td>Owners and funders’ knowing people (e.g., investors, senior managers, non-execs, consultants, academics)&lt;br&gt;Formal networking meetings (e.g., presentations at incubators, science parks, universities)&lt;br&gt;Previous business, deals, joint experience, jobs, investees&lt;br&gt;Existing personal relationships&lt;br&gt;Need for mentors, people with industry reputation&lt;br&gt;The biomedical community is well networked&lt;br&gt;In BP, people tend to know people</td>
</tr>
<tr>
<td>Interactions</td>
<td>Investors will want to get closer and more involved with people who have already made a return, made an investment, made value for investors&lt;br&gt;“Preparatory deal flow”… a project looking for funding is not shopped around a high number of VCs but discussed with people with whom prior relationship exists&lt;br&gt;Co-investing a “comfort blanket”… “it is not me being mad, but these other lads are also being mad…” “you can bring along a co-investor who specialises in…”</td>
</tr>
<tr>
<td>Availability of funding</td>
<td>Business Angels may contribute funds usually reaped elsewhere (non science-based sectors)&lt;br&gt;Venture Capitalists (Gap VCs, VC Trusts, Corporate VCs, Public (listed) VCs, Evergreen VCs, institutional investors) may provide funds and capacities&lt;br&gt;Charities may fund grant schemes&lt;br&gt;Government money usually provided through grant schemes&lt;br&gt;(No commercial banks, no family, friends and fools. Mostly, no founders either except for successful serial entrepreneurs that have accumulated some for-investment profits)</td>
</tr>
<tr>
<td>sources/mechanisms</td>
<td>Stage funding readiness&lt;br&gt;Very early stage (pre-organisation) requires more than funding&lt;br&gt;Early stage (pre-revenue) requires more than funding&lt;br&gt;Later stage (revenue) mainly requires funding</td>
</tr>
<tr>
<td>Investors’ characteristics</td>
<td>Investment fund sources (fund owners)&lt;br&gt;Investment window (funds cycle and timing)&lt;br&gt;Investment structure (alone, joint, who leads (due diligence))&lt;br&gt;Exit mode (sales, M&amp;As, IPOs)&lt;br&gt;Timing to raise funds, invest and exit</td>
</tr>
<tr>
<td>Trends of change</td>
<td>Developments in stratified medicine. “Business model” not understood yet. No clarity about test funding and IP rights in different settings&lt;br&gt;Corporate Venture Capital from big pharmas moving to invest in early stage projects/start ups&lt;br&gt;Charities are increasingly involved in financing (in the UK mainly)&lt;br&gt;Regulatory developments, especially regarding prospective “personalised therapies”</td>
</tr>
</tbody>
</table>

Initially, a matrix was formed so that the responses could be clustered around the main emerging themes. A successive exploration of the matrix contents led us to structure the relationship between the themes. The theme identification process is summed up and illustrated in Table 7. There, limited but relevant evidence from the interviewees’ responses is used to support the identification and reach of the main themes. It is not only a matter of frequency or semantic closeness; beyond that, we
have found that nearly all the responses about the roles and processes whereby decisions about the funding of innovative bio-pharmaceutical projects are reached include varied references to most of the themes herein listed. The themes and their underpinning issues constitute the backbone of the subsequent narrative where the evidence provided by the interviewees’ replies is articulated into proper relevant findings about the investment decisions that regard innovation in the bio-pharmaceutical sector.

The explanation of the different thematic categories and relationships is presented in Table 8 and supported by Figure 7. Essentially, the top two issues that help explain the investment decisions in bio-pharma are knowledge about the sector (by both project owners and investors) and networking. In a second level, interactions among players (essentially investors and venture owners, although others may also be present and relevant) support the top level elements. In the third level, the availability of funding sources and mechanisms and their readiness to fund particular project stages explain to a great extent the interactions (second level) and the knowledge and networking issues (top level). Availability and stage funding proneness are, in turn, heavily rooted in the characteristics of the relevant investors. Finally, some trends of change deemed relevant for the sector in the recent past help explain the present state of the three higher level issues and, together, these past and present trends help profile the near future ones and many potential mutations over time.

Table 8 – Explanation of relationships among the Main Themes

<table>
<thead>
<tr>
<th>THEMES</th>
<th>HIERARCHY AND RELATIONSHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about sector</td>
<td>Key for de-risking projects, assessing projects and team/company track record, making decisions on funding size and timing, assisting team/company in strategic managerial issues, planning exit</td>
</tr>
<tr>
<td>Networking</td>
<td>Key for accessing/updating/enhancing knowledge and capacities, spotting funding/investment opportunities, doing due diligence, coordinating investments, creating owners’/investors’ track record,</td>
</tr>
<tr>
<td>Interactions</td>
<td>Key for accessing/updating/enhancing knowledge and capacities, networking, coordinating joint actions, doing due diligence</td>
</tr>
<tr>
<td>Availability of funding</td>
<td>Key for successful interaction and networking, making contextually appropriate funding decisions</td>
</tr>
<tr>
<td>sources/mechanisms</td>
<td></td>
</tr>
<tr>
<td>Stage funding readiness</td>
<td>Key for making contextually appropriate funding decisions, funding structure (stand alone/co-investment) and horizon (follow on rounds)</td>
</tr>
<tr>
<td>Investors’ characteristics</td>
<td>Key for defining higher categories</td>
</tr>
<tr>
<td>Trends of change</td>
<td>Key for updating higher categories</td>
</tr>
</tbody>
</table>

Source: Author’s own elaboration
As mentioned earlier, the emerging themes are arranged into a self-supporting layout which implies that the bottom two levels are key to define the top three levels and the middle level (availability of funding sources/mechanisms and stage funding readiness) is essential to determine the interactions that make networking and knowledge acquisition possible (see Figure 7). Ultimately, the hierarchical arrangement of themes and their relationships create and sustain variety in the different decisions involved in the funding of an innovative project. This is important to remark because these decisions do not imply a simple yes/no dilemma and have long-term meaning and effects on the projects and companies involved.
4. FINDINGS

4.1 Introduction

The richness of the primary data entails huge complexity and demands great care in the analysis and interpretation of the said data. Therefore, we proceed to dig into the emerging issues in order to better understand and interpret their core substance and value, their underlying relations, their hidden implications and, ultimately, their meaning for the central topic of this research.

Thus, the remaining body of the present chapter is structured into two sections. Subsequently, section 2 unveils an articulate narrative that plunges into the deep conceptual and functional details of the categories, ordering, and relationships mentioned above. Thus, six sub-sections develop the arrangement of emerging themes into statement-based stories that seek to plot a coherent picture of how and by whom are funding decisions to support innovation in the bio-pharmaceutical space made.

Such narrative is profusely supported and illustrated by selected, relevant excerpts from the interviews in order to provide the distinguishing traits that cover the skeleton of the characterisation made of the concerning phenomena under study. Such traits eventually convey the idea of subtle but important variations in the story told.

Finally, section 3 sums up the main issues as a way to prepare the introduction of the explanatory proposal made in the following chapter.

4.2 A narrative to explain the findings

Our findings about the financing of the innovative projects in bio-pharmaceutical companies, particularly SMEs and start-ups, allow us to propose that the characterisation of this sector can be enhanced with a number of additional features. Those traits emerge from the analysis of the experience accumulated by the players that operate in the sector and can be identified and formally described in the following general terms:
- To start with, just like venture owners, investors need to have a certain understanding of key aspects about the sector and its sub-sectors (e.g., technologies, markets and products) accumulated over time and through their own and others’ experience. Such knowledge needs being revised constantly because due to some characteristics of innovative investment opportunities in the biopharmaceutical sector, specifically what regards knowledge creation, it can effectively be updated and enhanced by linking into networks of experts related to companies, to non-firm organisations in the sector (e.g., universities and research centres) and to other investors with analogous interests.

- In the second place, the networks just mentioned facilitate firms getting in contact with potential funders and funders locating potential investment opportunities, coordinating investments among different funders, updating and enhancing the financiers’ knowledge about science/technology and the track record of potential investees, venture owners’ learning about the track record and potential perks of getting funded by specific investors, and incorporating capacities into project/company teams including the investors themselves.

- Thirdly, interactions involve, beyond fund seekers and potential funders, other individual (e.g., experienced scientists, financial practitioners, senior non-executive managers) and organisational actors (e.g., university hubs, technology parks/campuses, incubators) in roles such as advisors, match-makers, contact facilitators, and evaluators. Such interactions are key for network-based learning other than for negotiating and completing transactions, for finding information about projects and other parties (e.g., due diligence), and coordinating joint actions once a funding agreement has been reached.

- Fourthly, innovation funding decisions, in terms of both processes and interactions, are essentially impacted by the availability of sources and mechanisms of finance in the local, regional, national and even the international context and the readiness of such sources to fund specific venture stages. Innovation finance is known to be essentially high-risk acceptant and needs to possess either a certain knowledge of the science/technology behind the projects or the channels (network contacts) to
acquire such knowledge in order to better cope with fundamental uncertainty and risk. That is why not all the theoretical sources and mechanisms of funding are ready to support innovative firms or at least not to the same extent. This is directly related to the “limited research space mastery” that firms and other actors exhibit characteristically due to the ever expanding knowledge base in a science-based industry such as bio-pharma. So, precisely because of high risk, true uncertainty, long-term commitment and other issues, the availability of external funders to act jointly means that a key part of understanding the sector and interacting in networks implies, to a certain extent, showing readiness to financially support ventures at certain phases and within investment schemes that pool funds from different investors under certain conditions.

- Fifthly, several specificities of investors help configure the top three levels mentioned above (i.e., sector knowledge, networking, interactions). The sources of the investment resources, the size and governance of such funds, and preferences about stages, co-investment, and exit condition their eagerness to fund innovative bio-pharma ventures and, consequently, have an impact on their interactions, networking and learning.

- Finally, some wide encompassing trends of change in the recent past or foreseeable in the near future, such as the ones emerging from personalised medicine or the storming of certain investors to fund particular venture stages, may have a powerful impact on the availability of funding sources/mechanisms since they imply a re-organisation of the relations and interactions among the players in the sector (an example of co-evolutionary processes at work if we were to use Malerba’s (2002) terms).

This is succinctly what lies behind the layout shown in Figure 7 and Table 8. Now, we proceed to deploy a narrative that intends to articulate the themes structure and relationships into an account that shows how much more there is to the decision-making of innovation funding than what is contained in the main explanations built up so far in the literature. This account is based on the features introduced above and is supported by relevant evidence (testimonial statements) provided by the
informants interviewed that help illustrate these issues and their underlying connections.

**Knowledge about the sector of investment**

*Investors need to have a certain understanding of key aspects (e.g., science, technologies, markets and products) of the sector where they place their funds and they can access, update and enhance such knowledge by linking into networks where additional relevant expertise is found…*

The investors’ knowledge is built gradually on the basis of the accumulation of hands-on experience and by linking with other sources of specific knowledge which the funders lack. The investors’ knowledge can always be enhanced if an effort is made to keep up with the pace of the developments made at least in a particular sub-space, if not in the whole space of bio-pharma, which is of course difficult and costly (see Table 9).

Company and investment managers confirm and explain that the sectoral expertise of investors very rarely gets to the deep and detailed level that the scientists working at the edge of scientific and technological development can exhibit. This is rather evident because in so many cases only the few people that have conceived and are involved in the research project have a moderately precise idea of where they are trying to get to and how that can be done.

Therefore, the investors’ knowledge necessarily changes as the core industry knowledge itself varies and the networks that facilitate access to such knowledge are modified by the entrance of new agents or the updating of the experience and knowledge of those already integrated in the sector networks. That is the main reason behind the importance of a continued networking effort: the experience and knowledge accumulated in the past may not suffice to understand a new investment opportunity that has not been charted before. According to several VC managers, even a certain background in a particular area does not guarantee the mastery of everything that needs to be known because much of the knowledge associated to given spaces and sub-spaces is so specific that experts are needed in so many regards (see Table 9).

The effort to access and internalise knowledge takes time, patience and persistence since, as a manager asserts: “... they [our investors] have spent seven or eight years
hearing me talk, hearing about what the company is, so they'll decide whether it's progressing or not.” (I 2)

However, in many cases the access to the relevant knowledge, at least at the depth required or desired, may be restricted by the nature of the innovative activity itself in a sector where intellectual property is a key asset, as several interviewees mention; innovative venture entrepreneurs usually work at the very frontier of knowledge and technologies, in fact they can produce them themselves for the very first time, so only a few people across the world may have the necessary expertise to really understand what the very technical details of a project actually are and imply. In such a case, it may well be that even external sources of the relevant knowledge are scarce and restrained (see Table 9).

An interesting example regards stratified medicine, an approach aimed at identifying the right therapy for the right patient since, according to an interviewee, most drugs on the market are effective on not more than 30-50% of patients because of the individual differences; for instance, in the case of cancer research “... some proteins that the medicine act upon are present differently in different populations. In short, it means that a certain drug for a given disease works for some people, but does not for others” says a scientist and company manager (I 5).

This developing approach is relevant for potential bio-pharma investors because it essentially means that some therapies may have to be completely re-designed or new therapies will have to be targeted for specific proteins and diagnostic tests have to be developed to prove the effectiveness of a drug according to the type of patient condition. This is bound to have a powerful impact on funding since it means that drug companies have to work closely with diagnostic companies.

The emerging scenario has created a lot of apprehension among VCs because it essentially implies the emergence of a different, if not an entirely new “business model”, which is still not understood because, according to the different national systems of healthcare research and funding, it is not clear who shall pay for the costs of development especially when fully State-funded healthcare systems and privately-held bio-pharma companies are involved and when “drug markets” will likely be largely re-defined in terms of smaller sub-groups (niches) of patients affected by a particular condition.
Table 9 - Knowledge about sector – excerpts from interviews (a)

<table>
<thead>
<tr>
<th>INTERVIEWEES</th>
<th>I1</th>
<th>I2</th>
<th>I3</th>
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<td>... I think the people that are left do either know themselves or recognise that can get somebody in who knows about the technology. Without that, people do not tend to invest if they don’t know something about what they are investing in anymore...</td>
<td>... you’re working with the leading edge piece of technology, globally, and there are a handful of people that understand what you are doing at the detail, detail... and sometimes even just one or two.</td>
<td>The funders actually are very careful with their money and they do a lot of due diligence before investing.</td>
<td>You can only have good results if investors have some knowledge and are enthusiastic about science. Only people who are passionate about science will invest money in that sort of projects today.</td>
<td>... when we talk about VC, we talk about a lot of different specialists, anyway, some of them will have the specific knowledge about... or certainly the contacts to be able to find the right set of technology, to make a good assessment.</td>
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<td>... a lot of them, the investors in the sector, are hands-on investors so they take direct seats on the board. So it’s not just money... it is ‘we are going to come because we can add strategically networks-wise’.</td>
<td>We cannot know everything about things that we invest in but we do tend to have a few things developed.</td>
<td>... I still think there is a lot of common things (sic) that you can carry from one area to another area because, I mean, the basic operational needs of a biotech company, the basic need to address unmet needs or unmet regulatory concerns, the different areas have the same sort of perspective on that. But we try always to engage on the board someone with domain knowledge and experience and we, of course, use consultants in the companies…</td>
<td>... in our firm we have recruited the investment managers that have operational backgrounds and we try to have them complementary to what we would have, knowledge from different parts of the process of creating drugs, you know, anything from the R&amp;D field to clinical developments or making (???), as well as having wide and different therapeutic areas so that it is possible for us to have at least some level of expertise…</td>
<td>... I think there is a need to bridge business and science very much. [As for decision making, it works...] in joint, like a collaborative effort... we... all strategic decisions are discussed and based on that…</td>
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<td>... it [knowledge about the sector] is the foundation of your investment business, really. And I think your domain expertise is critical... each deal you do gives insights into other deals through... through the things that get well and the mistakes... the mistakes you make as well.</td>
<td>I think it [knowledge about the sector of investment] is very important. It is key. We spend a lot of time on catching up with different fields if we are presented an investment opportunity. Of course, you are not expert in every single venturing area, but we then draw upon a network of consultancy and industry experts that we ask hopefully the right questions so we understand what risk we are taking in a particular investment.</td>
<td>... there is sort of two different sources of knowledge that are really important to do this job well. One is absolutely sector and market knowledge, but we also think that actually knowledge of basically being a good supporter venture capitalist... knowing how to work with companies, teams, build teams, build businesses’ plans for exit.</td>
<td>... successful investors all have people on the... people on their payroll to have a... extant experience in both science and medicine and business. It is really critical... you can’t be successful in this game without knowledge of the sector.</td>
<td>... To go out and see opportunities and to form a company yourself around interesting science requires a great deal of knowledge, I think, within the team. ... everybody in this business has scientific advisors and consultants because no matter how smart the team is, there is going to be fields that where you don’t have absolutely, you know, cutting-edge tip-top expertise.</td>
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<td>... no individual</td>
<td>... VCs in health care</td>
<td>... the vast majority I would say that</td>
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person can have all of the knowledge that is needed to assess a project, so… if you are an investment professional specialising in therapeutics… therefore you have reasonable time to build a background and reasonable medical knowledge of the… the team members, and markets, and drug discovery… are… you know, typically have PhDs and (?) who can come up to speed very quickly. They are going to know what… will also be very familiar in a particular therapeutic area whether it is oncology or infectious disease or basically whatever. They are going to have a very good idea of what to look for, very typically keep up with the literature and so… they are going to be able to understand and communicate with experts in the field, domain experts such as a professor or researcher in that particular area. of people that I deal with understand the bio-tech space incredibly well regardless of their educational background. … I prefer working with people who understand… because although things may go wrong, they have a better idea of, you know, what can go wrong, you don’t have to spend a lot of time kind of explaining the process to them.

[knowledge about the sector] is a major factor because I think that mostly in bio-tech is… there is too much science in it for somebody who has no experience to really understand. For sure [a funder’s previous experience is a major factor]; I think that they really could not understand what we were doing if they did not already have experience in our space.

Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

The implications of the emergent change go beyond the cost and payer issues. In fact, the repercussions will reach R&D in general, regulation, education of healthcare professionals, patients and other stakeholders. Research funding, in particular, will likely be affected through a number of channels and variables. Charities, for instance, are becoming increasingly involved and push for a modified approach to disease treatment in certain environments (e.g., the UK) but are almost completely absent in others (e.g., the US).

So, many actors are concerned about how will diagnostics work as a connected developing sub-space, but it is clear that so far there are many more questions than answers and, of course, each agent will carefully check its own position regarding benefits and costs.

… and that may mean different investor approaches.

Company managers specifically remark that some investors in the bio-pharmaceutical space are specialists, while others are non-specialists; the ones that specialise in the sector, they say, clearly have sectoral expertise. Such expertise regards what is behind innovative projects in the sector and has to do with the knowledge about the science behind the sector/project and what the usual procedures and processes are during project development; that is bound to happen mostly if an
investor specialises (i.e., has taken part) in many projects in that specific space or sub-space because greater experience means greater knowledge. That has, according to VC senior managers, important consequences; namely, a specialised investor can become a brand name life sciences funder and that means that such investor is going to have more than enough unsolicited deal flow (see Table 10).

Table 10 - Knowledge about sector- excerpts from interviews (b)

<table>
<thead>
<tr>
<th>INTERVIEWEES</th>
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<th>I10</th>
<th>I12</th>
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<td>Some investors are specialists, some are non-specialists, and if they're specialists then clearly they have sectoral expertise. But even if when they have sectoral expertise, they rarely have the level of detailed expertise that we have for the innovation or the technology.</td>
<td>“It is limited [investors’ knowledge] since the scene is very high risk. Therefore, there’s probably around only a small number of VCs who specialise in this area and they would probably do it either on a European or a global basis rather than just the UK. … actually, there is a good range of skills as focused on VC and bio-pharma; you have probably got technicians, you probably have got people with these academic backgrounds, you have probably got entrepreneurs who have run businesses in this field; so if they have had good success, they may now turn the table and become VCs themselves, so there is a good knowledge of how these things are run… Knowledge about the sector can be gathered in a number of ways… if you look at bio-science investment firms, a lot of the people have backgrounds in the life sciences; a lot of the partners at the dedicated firms have been chief execs of successful bio-tech companies or have had twenty years in AZ or whatever… running global R&amp;D…”</td>
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<td>… we try to sort of accumulate knowledge so, for instance, in NS we have now 3 portfolio companies working in the anti-infective space; there is none of us who actually have a background in that area, but now we work on several portfolio companies so, although we’ll never be anti-infective experts personally, at least we know some of the things to look for and have some kind of network in that area.</td>
<td>So… certainly in the London office we would never try to branch out into vaccines or into diagnostics or anything like that because we simply do not understand the sector. And when some of our colleagues have tried to do that, particularly in America where they tend to think they are invincible, you know, you get into real trouble because… you know, these are very, very difficult areas in terms of the science, of the technology, in terms of the clinical positioning, the commercial positioning. Non specialist investors, like typically, if they are sort of generalist investors, they will have a life science arm, an IT arm and maybe a clean energy, a lean tech arm, something like that. Therefore, the people we have been speaking to have always been some sort of specialists within life science, but again, life science is a very broad field and there is a huge difference of looking at cancer treatment and then anti-bacterials. It is two different games. … we are a sort of chain of resources and managers… that builds the company which I am part of… is split between life and physical sciences and there’s about seven or eight of us in total; we each have some level of sector expertise or specialisation because of our backgrounds.</td>
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<td>You probably follow up (things like digital health, which are sort of new areas) for some time, you reach reviews, you are happy talking about that during conferences… you know, get a feel as to whether it fits your strategy. But, you potentially get in people who can provide you with leadership, insights as consultants or as venture partners, maybe… you know, somebody who’s got particular expertise in that area…</td>
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... for example, healthcare IT which is an interesting space at the moment, but we don’t have any experience in that space among our partners in the organisation as such, so we would say that is outside our investment scope; it is an interesting opportunity, but no, thank you! No, [we would not do it even if there is some co-investor with experience in that particular area], we need to understand exactly what we do ourselves.

... And it is not just a case of you are a smart person, you have got an MBA, you basically understand business analysis and you understand sectors and trends, then you can be a good investor; we actually think that is a part of it, but that is almost as important and maybe even more important as you get to later stage businesses is... is that ability to recognise patterns, to intervene to help get things back on track, to facilitate change in management teams if needed, and then to provide extra support for the teams if needed, and to have one plan... plan for exit, to work with advisors to... we think it is more of an art to do that that actually you can learn from experience and people.

[Knowing people who have the expertise is critical. I think it is OK in terms of moving within therapeutic areas, which is what you are talking about exactly. I think along as you can [talk] to a proper expert outside of... your particular company, I think that works fine.

I think it is hard to be a lead and to..., especially if you lead in company formation, without having... you know, sort of deep scientific understanding within the team... and I say that as a guy who is not a scientist... I know a lot about starting companies, but I need to that and collaborate with people who can tell the really great science from the really good science.

... you’ll get some [knowledge] just [by] doing deals, that is just experience that is not proper science, a little bit about company operations - which, again, you get from sitting on boards and being involved in the running of the companies - and then... and then everything else, that is the expertise on setting the market and maybe a bit of technology, and that kind of thing... you generally outsource that...

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<td>The most successful VCs are going to invest in an area in which they have some expertise, now they are not going be the world’s experts in the cutting edge... you know... new molecule, but they will know who to go to do their technical due diligence, they know what types of questions to ask initially to screen whether this is something truly novel or not.</td>
<td>... about half of the people who make the investment decisions in the bio-tech space are actually CFAs, and so they have no scientific training, no medical training, yet they have been working in this space for twenty/twenty five years and they know all there is to know about drug development, what can go right and what can go wrong.</td>
<td>[I think that the information they have just helps them valuate whether the prospects for the product you are bringing to them are worthwhile or not. So, you know, I think without that knowledge, they just cannot make a very big surge in.</td>
<td>Most of them [VCs] were dedicated, that kind of investors. Pretty much.</td>
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Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

In the case of generalist funds, however, most of them seem to be highly averse to even considering bio-pharma type opportunities because the capital requirements and the time to exit are so long that it is not really a sensible place for those funds to invest. This is particularly true when economic cycles take a downturn or when a given sector is hit by real or perceived negative factors. Consequently, generalist
fund managers do not actively hunt for deals in the industry, although they can be sometimes approached by companies (unsolicited deal flow). This statement clearly brings forth the existence of a divergent strategic intent among potential investors in bio-pharma. Apparently, an interest for specialisation leads to increasingly building up knowledge about the sector, whilst a generalist approach prevents investors from getting into the deep details and toils of sector-specific investment opportunities (see Table 10).

Sometimes, in fact, the interest that leads investors to specialise may originate in the source of funding itself and the very goal of setting up the VC fund (we shall return to this later); take, for instance, the case of a Gap VC fund in the UK which, by mandate, cannot provide money to companies that receive State aid greater than 1.2 million for an initial twelve-month rolling period (although this cap gets lower in subsequent periods). This fund’s investment capital was raised within a joint funding initiative between the European Commission and the European Investment Bank and it is specifically addressed at the biomedical area in a particular geographic region: “[a] hundred percent of it is to be invested in the North-West of England and half of it in the Merseyside area in companies established here or wanting to move into this geographic area”, according to its manager (I 11).

**Networks**

*Networks facilitate updating and enhancing knowledge about science/technology and track records...*

Different VC managers point out how networking is a feasible mechanism to deepen the funders’ knowledge about the science or technology behind an innovative project that may be so in the frontier that virtually only the person(s) behind it can really understand it. This, of course, creates a cumulative effect over time that helps funders enhance their knowledge about the sector as a whole about the science and technology, the regulations, the market, and the competence. Knowledge of the sector and networking are closely related because the wide nature of sectoral expertise in bio-pharma is such that, in the words of a VC practitioner, a great variety of experienced figures can be reached out at for their knowledge so “… it’s all
credentials, it’s all networking… consultants, ex-portfolio executives, non-execs… There is a lot of recycling for non-execs.” (I 10)

Table 11 - Networks – excerpts from interviews (a)

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<td>There has to be real credibility around what’s being presented… the credibility comes with people who have already done it, made a return, made an investment, made value for investors, and the investors will follow on, they’ll want to get closer and more involved with that individual, as well as the company.</td>
<td>Very few [things are done on cold contact]... I would only do something like that if it was, number one, very interesting, and number two, there is a good management behind that. It does not really happen. Usually the stuff that is more common considered and real would come through an introduction.</td>
<td>Most opportunities are introduced by advisors, corporate financiers, mostly generalists, attached to accountancy firms. ... there are also universities in the region that have some sort of commercial arm that showcase bio-tech companies.</td>
<td>A big reason behind the networking strategy has to do with the fact that it is such a broad field that even if you have a background in a given area in say, clinical developments or discovery research, you can’t be a master of everything that you need to know. You can go so far generically but these things are so specific that you still tend to need an expert…</td>
<td>Most opportunities are introduced through networking meetings where the fund and its experience are presented to broader audiences. Other interesting scenarios are business breakfasts organised at the science ark and meetings with company portfolio managers because these people usually sit at some other companies’ boards that may refer the fund investors to a number of new firms.</td>
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<td>… we do have very good relationships, clearly with IC (a university), we still manage the technology transfer business for IC and so by the tech transfer office we see lots of projects coming out of this university at very early stages so that we can get our heads around for a long time …</td>
<td>… we are constantly learning and trying to exchange knowledge within the group here and also, to some extent, with other investors. We are generally very good at... we work close together and share… each of us have different networks and share that.</td>
<td>I go to the ones [funders] that fit best to that project… so you can look at the portfolio of companies they have invested in, of course you know they have a specific target and so on for their investments.</td>
<td>Well, I think, of course they always engage with experts to evaluate a project, so that is sort of one [reason]. The other thing is that we have an advisory board so… people who are well-known and sort of well respected; and if these people have put their name on the project, then I think it sends a good signal.</td>
<td>… to get into the late stage opportunities it is more about getting to know them over a period of time and getting to know the management team… when at the early stage; so often it is the management team, so you are not forming a view on people so much. And I think the networking actually is important for getting to know people and businesses, so I would say it [networking] is more important for late stage.</td>
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<td>… we were going out getting our own deal flow, and then all the other firms were doing the same and, I suppose, we would be going into meeting the same groups, but not knowing who else they were talking to. But you do tend to… you tend to sort of share, I suppose, sort</td>
<td>So, there is sources of technology – the universities' network, there is sources of money – the financial networks, sources of management talent – that is the resources networks, then there is the network of industry players – which is companies or businesses making</td>
<td>… lots of opportunities come through companies, people, other venture capitalists that we have worked with in the past.</td>
<td>… if we see something we like, we are probably, you know, especially if we are likely to do it, you know, we trust in our judgment in that area. In some other areas, you know, we need to go find somebody in whose judgment we trust. And my guess is that</td>
<td>… it is tough because you don’t have reputation.</td>
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of… deal flow at an early point if you think that is a certain compatible investment strategy and you think 'you guys have seen that company, you know… we are starting to do some work on it…, you know, is that something that you are looking out and…’ you know, those are the kind of early conversations that can also lead to syndications.

eventually these…
even when we do that, when we find someone that we have worked with before who is, you know, we think he is a real expert, we are still going to, you know, sort of need to do some learning out around and become at least temporary experts in the area.
drug and I was, obviously, responsible for that.

Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

Non-executive board members, for instance, are in fact a great source of deal flow in the space because they may have a portfolio of several companies and they are usually closely linked to different types of funders, so they can easily recommend potential investment deals based on their experience, inside knowledge and ties to specialised investors. Thus, the combination of knowledge and networking can bring forth potential deal flow for investors (see Table 11).

Of course, knowledge enhancement about the bio-pharmaceutical space and its sub-spaces is also a way for the investor to build up a track record and to incorporate or update capacities that can be referred to and used later as necessary. In fact, at least in the case of sector-specialised funds, it seems to be quite usual that many staff members have a background in life sciences and some non-negligible experience as CEOs/CFOs and board members of successful bio-pharma companies so they understand the business and the projects and know their peers so they count on a substantial network. For many project owners, other than money “… this is the value they can add… So it’s not just money… it is ‘we are going to come because we can add strategically networks-wise’” (I 10)

Thus, knowledge enhancement with investing purposes involves networking actions, but also calls for the engagement of the different players in such a way that the networking effort becomes as efficient as possible. In fact, the innovation manager of a UK university hub focused on bio-pharma highlights the need for different coordinated initiatives where each party leads a relevant role: “... some of them [specialised investors] will have the specific knowledge about... or certainly the
contacts to be able to find the right set of technology, to make a good assessment.” (I 5) These actions jointly produce visible track records for the investors’ companies involved making them highly visible and desirable in the eyes of project owners in a particular space or sub-space (see Table 11), which leads to the next issue.

...funders locating potential investment opportunities...

Investors’ deal flow is then built to a great extent through networking on the basis of different mechanisms, including previous investment experiences. Both VC and company managers reckon that not all companies have the same need for money and many of those that seek funding may have already created a previous relationship with some funders (what is usually called a selective set of deal flow) (see Table 12).

The usual potential deal finding and networking mechanisms used by certain funders, particularly those specialised in a sector, may include but be not limited to attending and partnering conferences in the sector or visiting universities to scout for projects so to ‘bias what sort of deal flow you get.’ (I 10) Of course, not all funders find this strategy the most suitable. Generalist funds, for example, rarely use it or do it to a minimum because it entails substantial time and money costs.

Moreover, the importance of wide networking is highlighted by VC practitioners who consider that the management of firms which they have worked for may be an important source of deal flow since some of them are able to do scores of transactions a year and “… [I]that allows them to make a lot of networking with the non-executive directors’ community, former investees and the like.” (I 9) VC investment managers with a focus on the bio-pharma field take a rather active stand to identify and approach investment opportunities and private equity practitioners will always be looking to establish a direct contact with the firms themselves or, alternatively, with their advisors and other organisations around or related to the companies (e.g., incubators) (see Table 12).

In point of fact, networking activities go beyond board members. In many cases potential deals are introduced by advisors and corporate financiers attached to consultancies and small accountancy firms. Other networking opportunities are related to some universities which have a sort of commercial arm that showcases bio-tech companies. Also, in some cases, universities (such as Manchester and Sheffield in the UK and others in Europe, not to mention most of them in the US) have seed-
funding capacity and they contact different potential investors for early rounds of financing or, slightly later, to look for co-investors. In the UK in particular, because of the profile built by regional funds in “the old days” of public sector regional development agencies, some opportunities came in directly that way.

Table 12 - Networks – excerpts from interviews (b)

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<th>INTERVIEWEES</th>
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<td></td>
<td>… YFM were one of the people they were already talking to and had not managed to secure investment, so we persuaded them and they then went on board and we got us a good relationship with them…</td>
<td>… I knew the chief executive of AAA from before, out of… I held an enterprise fellowship from YF that provided a fellowship that came with an industrial mentor who was the CEO of AAA. So that personal relationship that we had also made it very easy…</td>
<td>The recourse to &quot;traditional&quot; investors is preferable. Trusted VC funders with whom you have had a previous relationship… I have built a network of contacts since in 1989 I co-founded and was COO of GGG, a company listed on the stock exchange starting in 1996 (Nasdaq and Paris).</td>
<td>… we often have people coming in from GSK or any of the other bigger companies to do a bit of scouting… and there are also a number of different advisory groups for those external people from industry coming to university, and that’s quite a good way of finding out what industry wants and for them to see what we’ve got enough of here…</td>
<td>My network is actually quite academic as well… so the ‘universities’ Technology Transfer Office… usually comes through to me that way.</td>
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<td>19</td>
<td>A final source of deal flow is the more established firm management you have worked for. Some are able to do even as many as 100 transactions a year. That allows them to make a lot of networking with the non-executive directors’ community, former investees and the like.</td>
<td>The usual networking and business finding mechanism for dedicated funds includes attending and partnering conferences in the sector or visiting universities to scout for projects so to “bias what sort of deal flow you get” so you build up your network of contacts. A reason for generalist funds avoiding this strategy has to do with time and money costs.</td>
<td>… further opportunities are spotted at participation in spaces such as the UK’s YESS Programme, technology transfer at European Universities (ESTP) and every programme where I am invited to teach. Interestingly enough, no referrals are made by banks, intermediaries, patent agents or lawyers.</td>
<td>… Into the other universities, we have a different relationship; we don’t have the one-one technology transfer relationship, we don’t have any formal relationship with any other university but with IC. With everybody else we are out there, we talk with their TTO, we talk to their academics directly, we try to get a feel for who’s hot and who’s doing hot new things… and then we sort of try and tag ourselves a long way back with that group of people, with that research group to see whether that is something that we can ultimately shape as a spinout.</td>
<td>… we have a NS geographic area [beyond Denmark], which is the Nordic region, so Scandinavia, Finland Iceland, so we’ve been present at assort of local meetings and that is the main source of deals we get… are from being known either in exposure through those kind of things or actually through our own network.</td>
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<td>114</td>
<td>… it [deal flow origin] is a broad mix… But normally what</td>
<td>We’ve met with some business angels… We have been open to</td>
<td>… I think the networking is important. Because of</td>
<td>… we were to provide them with some… (sic) you know, a</td>
<td>We don’t directly approach individual researchers, but what</td>
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<td>117</td>
<td>We've met with some business angels… We have been open to</td>
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</table>

96
happens is that an opportunity is identified by an entrepreneur which may be an opportunity which is coming from academia, research institutes, and that entrepreneur brings us the deal. So it is not common for a university to call us up and say ‘we have this great idea’ with everyone to spin out the company because the university is not very good at doing that sort of thing…

<table>
<thead>
<tr>
<th>I21</th>
<th>I22</th>
<th>I23</th>
<th>I28</th>
</tr>
</thead>
</table>
| We [also] have a strong, a regular relationship with CBX and… I think many of the projects that are incubated there actually apply for grants in our programme. | … and, you know, the potential purchasers of our investment… companies. So that is another important network, there are others… I am sure there others, as well as, of course, general networks of lawyers and accountants and people who provide important services for our businesses… | … so we had to invest quite a lot of time in getting to know that advisory community, making sure that we are on their list so they know what sort of deals we like and to make sure that we get a few of those. | I was working enough to head up CHS for eight years and, I think, a probably did… well, I know, I kept track of 1,500 individual investor presentations. And that is what you have to do to get people to know you. 

… there have been a few people, there are investors who ???

and say ‘Hey, I understand you have a new company right now, you know, when you come to New York, come and see me’ but, you know, that may happen every now and then… but most of the time it is the… it is the company that wants the investment reaching out to the investors. |

Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

Finally, VC management pinpoints other formal networking mechanisms that some specific VC organisations often make use of; investment opportunities can be introduced through networking meetings with broader audiences, at business breakfasts and other similar meetings at science parks and incubators, and at meetings with company portfolio managers that sit at some other companies’ boards.
Additionally, further contact and networking opportunities are spotted at participation in spaces such as the [UK] Youth YES Programme, technology transfer spaces at universities (e.g., ESTP in Europe) and “every programme where I [a VC manager that keeps links with several universities] am invited to teach.” (I 11)

Yet, VC practitioners also stress that, interestingly enough, in their experience no referrals are made by banks, intermediaries, patent agents or lawyers which are also highly engaged players (except for banks) in the innovation system of the sector. Nonetheless, a further useful dimension lies in the fact that the bio-medical community around the world, and obviously at local level, is in general well networked and “that constitutes a big advantage concerning deal flow for funders.” (I 11)

... and, complementarily, firms getting in contact with potential funders...

Both, bio-pharma company managers and VC practitioners assert that funding for a project/company is more easily obtained if there is a previous connection (e.g., personal acquaintance, prior business, previous satisfactory results) between the project owner and the potential external funder; on the basis of the so-called ‘preparatory deal flow’ where “a particular project looking for funding is not built up and shopped around a high number of VCs, but discussed with people with whom prior relationships exist.” (I 10) This is related to the existence of trust, a factor that can only be built over time and sometimes may require the intervention of a middle person. Fact-based trust, that is confidence built upon positive achievements such as the respect of project deadlines and the accomplishment of established milestones, is the best facilitating factor in a new funding relationship according to the statements of several VC senior managers (see Table 12).

If fund seekers are unknown, it proves very difficult to start with. In the words of an interviewee: “You need an angel if you like, you need a mentor, you need someone to get long sight who’s got the industry reputation to make it happen for you, because without that it’s very difficult to get off the ground.” (I 2) Fund raising demands a knowledgeable management team with a track record, reputation and networking in the relevant space. So, working with somebody, a management team or at least one or two people who have an industry reputation and can point to what has to be done,
makes it easier for the project owner and for the investor himself to interact and to get to agreements.

In order to get credibility in relation with the projects proposed to funders, it is necessary to have “… people who have already done it, made a return, made an investment, made value for investors” (I 2) so that the investors will want to get closer and more involved with the well-known individual(s) as well as with the company and will probably follow on if necessary. From there, it is necessary to keep expectations realistic and aligned with delivery; otherwise it may become a recipe for disaster.

Oftentimes, trust does start with personal links and, then, moves onto the organisational plane where it becomes rooted in the established background and the track record of achievements of the companies involved, as meant in the statement of a company manager: “you have to keep a very careful hold on setting expectations for investors against delivery from the company.” (I 2)

Engagement-oriented factors in networks are also essential for funders and fundees not only in terms of building deal flow, as the following item illustrates.

... coordinating investments...

Networks are also instrumental in structuring the participation of different funders that desire to support a company or project financially. A funder recognises that in bio-pharma one can see both a competitive business where investors try to beat their peers, but also a set of people/organisations that co-invest on a regular basis because they have to and have done so in the past, so lots of deal flow comes through networking among investors. This is related to the fact that in this industry, as in others, “people tend to know people” so that probably more deals are done by investors who already know other investors, investees and other people in the business (prior relationship and trust) than on the basis of “a cold business plan.” (see Table 13).

Interestingly, networking seems also useful inside the investing organisations as co-investing decisions may become a sort of “comfort blanket” for investment decision-makers to justify and get support for their choices about fundamentally uncertain and risky ventures. As a matter of fact, a funder states that in many cases networking to fund a company or project may effectively become a driver behind VC funding
decisions in the sense that a practitioner can go to an investment committee and say “it’s not me being mad, but these other lads are also being mad.” (I9)

Table 13 - Networks – excerpts from interviews (c)

<table>
<thead>
<tr>
<th>INTERVIEWEES</th>
<th>I9</th>
<th>I10</th>
<th>I12</th>
<th>I14</th>
<th>I16</th>
</tr>
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<tr>
<td>Universities… also have seed-funding capacity and they contact regional funding investors for rounds B and C, later, to look for co-investors. So private equity practitioners will always be looking to go out direct. Probably not direct to the companies, but to their advisors and institutions around companies, places like incubators and such. … so they [specialised investors] intimately understand it and they do know their peers and they have got a great network and that would be part of what differentiates it. This is the value they can add.</td>
<td>… we are also investing in companies that have already been established as long as they have good connection into the university. There, I guess, we draw more heavily on our network of other contacts; so our network of other contacts might well be other venture capital firms that have invested in them, angels or other people within our network we are respect and known very well, who want to bring us into deals or management teams that we have worked with before who are looking at starting something up that meets our requirements. [our network is huge] … I think that is, actually, the fundamental of success. You know, new funds find it very difficult.</td>
<td>I think they are happy to actually build a syndicate, so that is the way that most… I don’t know… projects should be driven. First of all, it is nice for the people who drive the projects that you have a syndicate because then you have, of course, also then a balance to talk with different investors. And, of course, it is also nice for the investors that … [that there are] more than one just to drive the project.</td>
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<thead>
<tr>
<th>I19</th>
<th>I20</th>
<th>I21</th>
<th>I22</th>
<th>I23</th>
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<tr>
<td>… you want to know about the business that you are investing into, but you also want to know about your co-investors because if they back out, it’s going to leave you with a problem which is a company that you can’t fund and that is going to adversely, potentially, affect your value. So… I mean, I think a lot of it is about personal relationships as well as understanding strategies.</td>
<td>… I was talking about these partnerships and networks; there is a lot of European funding for these networks which is an excellent way of pooling resources and leverage. So they have become increasingly important. Then we have a network of venture investors that we can reach out to, we have a network of pharma executives, ex-pharma executives, you know… and commercially-oriented people that can evaluate the opportunity… we have our network from our past research history.</td>
<td>… because what we do is we don’t invest alone, we invest hopefully in syndication with others to, you know, mitigate the risk and to validate the propositions; so, you know, someone else wants to also invest, you feel more comfortable that you are not doing something weird…</td>
<td>… And our deal flow came through our co-investors, so other firms that we syndicate with, it came through our non-executive director network and chief executive network and just about anyone in the industry we are in…</td>
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Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration
The main point there is that if you are a generalist investor, you can bring along a co-investor who knows what they are doing in the sector. Thus, the knowledge, experience and reputation of a specialised investor can benefit generalist investors through networking. The problem in the biotech world comes forth if investors have not got a good track in the Venture Capital Trust (VCT) world in order to raise enough money to invest (from potential limited partners) or if they belong to a more conventional structure (i.e., generalist funds), unless they are corporate investors (i.e., the investing branch of a manufacturing company) (see Table 13).

This, then, brings us into another interesting feature associated with networking, that of building up the organisations’ capabilities.

... and incorporating capacities into project/company teams, including investors themselves.

Yet, networking is not exclusively related to fund-raising as it also involves other relations among players. It has to do with improving the knowledge of some particular sub-space in the industry, verifying track records or coordinating certain actions. Moreover, since networking is undertaken by all types of actors in the sector, organisational and individual players become entangled in a multidimensional system that may function bi-directionally and that grows continuously as the different actors broaden up their links with potentially useful new players and even help them play polyvalent roles in the network (e.g., university scientists that become advisors to VC operators or managers, VC practitioners that become company board members) (see Table 14).

Finally, it is worth calling to attention that building up the trust necessary to ground networking is not an easy task, either. Company managers explain how they face serious barriers to start contacts with some potential funders such as charities on the basis of providing technology packages for free so they can be tested with patients and feedback offered on the experience. Apparently, non-transactional relations may be seen with suspicion in a sector where knowledge is usually seen as equivalent to money (see IPRs) as can be inferred from certain experiences.
### Table 14 - Networks – excerpts from interviews (d)

<table>
<thead>
<tr>
<th>INTERVIEWEES</th>
<th>I2</th>
<th>I3</th>
<th>I10</th>
<th>I13</th>
<th>I14</th>
</tr>
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<tbody>
<tr>
<td><strong>If they [entrepreneurs] are unknown, if they’re starting afresh, it’s quite tricky to start with; you need an angel if you like, you need a mentor, you need someone to get long sight who’s got the industry reputation to make it happen for you, because without that it’s very difficult to get off the ground. You have to be working with somebody...</strong></td>
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<td>AAA was already operating in fields where ABC needed to move, so they were already established players and that makes market entry much easier, that was the major reason. In terms of science, the reason very clear; they had expertise that we do not have in the manufacturing of instruments, and we had expertise that they needed...</td>
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<td>A lot of life-science funds use, for deal flow, entrepreneurs in residence, &quot;people who are chief executives of a portfolio company and they bring them into the venture firm and use them to help build up propositions whilst they look for the next thing they are going to be chief execs of.</td>
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<td>So it is the network, being visible in the area, and then, of course, the most pre-seed grants and seed investments we do, people know about them and see what we are doing and learn about us that way. We do a little scouting and that is typically in the form of... we've been sitting down for instance selecting an area of given diseases and looking at who've done interesting publications in that area and we try to contact them. But maybe in two or three of our portfolio companies you can trace some origin to that scouting, but also that is not something that we pursue a lot and simply we don’t have much time for that.</td>
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<td><strong>The investors and our advisor board have been particularly helpful in giving us some challenges and feedback and... We have seen the process a lot of times; they know... sort of they have an idea on where the problems can arise and they have asked us questions and prompted us to investigate things further, so we’ve done that.</strong></td>
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<td>So we do have a level of sector expertise within our own team. And we do bring in outside experts for those opportunities... we don’t do all kind of work though, sometimes when we do lay things to be outsourced... due diligence, we do the due diligence ourselves, but we do rely on our network of experts...</td>
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<td>I suppose part of it is also... one thing to... potentially pick up deal flow from them [other firms] so that they understand your strategy and they know what you might actually be up for.</td>
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<td><strong>... we do have a pretty good network of serial entrepreneurs that we can, you know, draw upon for a particular project. Many of our projects are small and virtual, so the same person can maybe be responsible for... or work in two or three projects at the [same] time.</strong></td>
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<tr>
<td><strong>... another network you have to be involved with as an early stage venture capital fund... is a network of potential management talent, so that we do by mainly being close to the recruitment firms... the specialist recruitment firms who specialise in pulling people into small companies, they have themselves got huge pools of people on their resource...</strong></td>
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So, I mean that is two thirds of our deal flow come in from advisors and ACP originated; the rest, most of the rest, is truly direct approaches from companies and then I squeeze maybe five percent is other investors or other non-execs and chief execs through their networks.

It would be rather easier for small bio-techs who hire someone who has already done it, you know, gone through networks, investors, investor firms, bankers, analysts, you know, fund managers, rather than to start from scratch from somebody who is not known to anybody, who does not have the reputation…

I was introduced actually to someone in a venture capital firm. But in terms of kind of this network of people who have succeeded before, it was not really quite my story.

Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

This is superbly illustrated by the case of a UK innovative bio-pharma company which has recently tried to engage with medical research charities to partner with them so they supply the company’s technology for free to academics funded with charitable funds in return for feedback about how the technology works for them so that the company can use it as marketing material for paying customers. Incredibly, the company has found it very difficult to engage with the charities and the reason is not clear, although the hunch is that they might just be suspicious that somebody comes saying ‘you can have something for nothing’ (I 3); they may not think it is genuine in spite of how well packed it is.

Networking to identify investment opportunities is, then, based on confidence, and this is ratified by all company and VC managers alike and illustrated by a funder’s statement: “Working with credible people, people who have a demonstrable checked record, is the best way to mitigate risk.” (I 10)

Thus, variations in networking also underlie differences in knowledge accumulation.

Knowledge about the sector and its innovative projects is the reason why, according to different VC managers, if a given fund is not a dedicated fund, exposure to life sciences will not tend to be in the full in therapeutics, which means that their portfolio will typically include only a smaller, even negligible share or bio-pharma innovative companies or projects (see Table 14). A senior VC manager considers that the sector will always draw the attention of those funders that are geared up to invest because “healthcare issues don’t go away” (I 10); however, because of the
characteristics of bio-pharma innovative ventures (particularly the long-time scales), funds will have different approaches particularly concerning early or late stage issues and how much value they as investors can add.

Additionally, VC management bring into play the role of diversely sourced VC funds and remark the importance of corporate and State sourced VC as different from independent VC funds. In the first case, some important modifications over time have taken place since corporate investors have relatively recently started playing a bigger role in funding early stage innovative ventures in Europe, “...they’ve definitely moved downstream from simply wanting to pick up late stage clinical programmes [and they are now] involved in a lot of the earlier syndicates and continue to support early stage companies.” (I 10)

In the second place, without government support it would be even harder to try to take early stage life sciences businesses off the ground although that is truer in some places. For instance, the UK Technology Strategy Board (TSB) initiative is considered by all entrepreneurs, managers and financiers an absolute life blood for a huge lot of life science companies. Thus, TSB and new initiatives such as the recently started biomedical catalyst fund are essential to the bio-pharmaceutical space and similar appraisal is found, to a lesser degree, in settings such as some Scandinavian countries and France. On the contrary, bio-pharma players in the US do not attribute such great importance to State funded initiatives.

The differences in the investment strategy of funders seem to be strongly rooted in the knowledge that can be amassed about the innovative activities of a sector and its different sub-spaces. The funders are actually very careful with their money and they do a lot of due diligence before investing. Some company and fund managers explain how specialised knowledge about the space and sub-spaces can be accessed by financiers through the use of different strategies such as incorporating their staff members into the management of portfolio firms or by recruiting staff members from or building up steady links with the academic sector so they can be used as informal or formal consultants in order to facilitate access to the specialised knowledge that underlies investment decisions in bio-pharma (see Table 14).

The point is clear, even if the investors themselves do not possess the knowledge necessary to understand the basics behind the project/company, they may find ways
to access and internalise such knowledge so their investment decisions are as solid as possible.

The understanding concerning investment opportunities in the sector is that a very low percentage of the projects funded will be successful and, even in that case, only a low percentage of those successful ventures will involve a substantial return to make up for the losses and the non-highly profitable accomplishments. That is the principle behind the construction of the portfolios of specialised investors.

Thus, although they accept that there is going to be some unavoidable technology failure given the characteristics of the projects funded, investors do need to make sure that they are identifying at least one successful company for every ten that they invest in. They are ready to accept wastage, but they do have to do some deep and serious due diligence which contributes to make investment decisions costly in terms of time and money.

A very important aspect of due diligence, at least in the case of specialised investors, regards setting up the appropriate mechanisms to gain the necessary knowledge in order to better assess the investment opportunities. Networking and business finding mechanisms for dedicated funds usually involve attending and partnering sector events such as conferences or visiting research units or technology transfer offices at universities in order to spot projects so investors can selectively build up their deal flow. Generalist funds avoid this strategy as it demands lots of effort, time and money, according to several senior VC managers. This can help explain why the networking task is, then, a decisive component of the strategy of specialised investors in the sector (see Table 14).

Only specialised VCs’ seasoned managers take an active stand to identify and approach investment opportunities; VCs and other private investors will always try to establish a direct link either to the persons or to the companies or their advisors and to the institutions around the companies of interest and that means places like incubators and business parks. That is when and where VC practitioners can take advantage of their prior experience and contacts; in fact, many of them recognise that a final source of deal flow is the more established firm management they have worked for which allows them to extend the networking onto the non-executive directors’ community, former investees and the like. Nonetheless, networking
remains a complex operation in itself given the heterogeneity of the actors that take part in the bio-pharma business sector.

The importance of networking is proportional to the quality and importance of the knowledge it can bring into the investing organisations. That helps explain why specialised funds heavily involved in financing bio-pharmaceutical ventures are always interested in attracting people with backgrounds in the life sciences, people that have experience as chief executive officers of successful bio-pharma firms or that have years’ experience running global R&D and marketing functions. It is all because they have an intimate understanding of the space, know their peers and have a huge network. That is the value they can add.

Yet, it may be not enough. A big reason behind the networking strategy has to do with the fact that bio-pharma is such a broad field that no matter your background in a certain space or sub-space, whichever it may be, there is no way to acquire and keep updated the deep and detailed knowledge you may need to make the best decisions possible; in the end, most VC managers recognise, you will still need an expert in the subject. That is why a track record and good networking are essential. And that is also a reason for many VC investors to decide not to move into sub-spaces which they are not familiar with even if such sub-sectors may potentially contribute a nice share of deal flow (see Table 14).

On the other hand, funds that have decided not to concentrate their investment in bio-therapeutics –that is to say, generalist funds– spend less time building and maintaining that sort of a network, which means that less specialised knowledge about a given sector is accessed and internalised. Conversely, if all a VC fund or any other type of financier does is life sciences, it is much easier to develop and sustain a very productive network.

Furthermore, VC investors insist that networking to identify investment opportunities and internalise knowledge is based on confidence. This is ratified by all the VC and company managers interviewed; knowledge and trust involved in networks are a basic factor to manage risk to the extent that it can be managed in this type of projects. One of the VC managers puts it in simple terms: the credibility of people lies in a demonstrable track record that can be double checked. Credibility is the key to identifying, understanding and “managing” risk in bio-pharma sub-spaces. That is
why people and their history are so important when projects/companies come forward in the search for funding.

In short, knowledge and networks are closely related in the financing of innovation of the bio-pharmaceutical industry as can be deduced from the multiple meaningful coincidences that are summed up below (Table 15).

Table 15 – Knowledge and network links in the funding of bio-pharmaceutical innovation

<table>
<thead>
<tr>
<th>Knowledge Subjects</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing and emerging science and technology in sub-spaces</td>
<td>Understanding investment opportunity risks</td>
</tr>
<tr>
<td>Markets and products</td>
<td>Understanding environment</td>
</tr>
<tr>
<td>Institutions (e.g., regulation, IPRs, trust)</td>
<td>Establishing track records (companies and co-investors)</td>
</tr>
<tr>
<td>Players (e.g., competing/collaborating companies, universities, research centres)</td>
<td>Understanding sector/sub-sector dynamics</td>
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<tr>
<td>Other funders</td>
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<table>
<thead>
<tr>
<th>Networking Partners</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior partners/colleagues (different organisations and milieu)</td>
<td>Locating investment opportunities and potential (co-) funders</td>
</tr>
<tr>
<td>Emerging science/technology figures</td>
<td>Building up fact-based trust (e.g., track records and prior personal links)</td>
</tr>
<tr>
<td>Fellow investors (particularly, seed funders)</td>
<td>Building deal flow (see successful past relation and third party recommendation)</td>
</tr>
<tr>
<td>Board members (particularly, non-executive managers)</td>
<td>Coordinating investments (i.e., syndication)</td>
</tr>
<tr>
<td>Consultants</td>
<td>Updating and enhancing knowledge about science and technology and competition (e.g., track records)</td>
</tr>
<tr>
<td>Sector associations</td>
<td>Incorporating capacities into project/company teams</td>
</tr>
<tr>
<td>Science parks, incubators, university hubs</td>
<td>(including investors themselves)</td>
</tr>
<tr>
<td>Others (e.g., corporate finance boutiques)</td>
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Source: Author’s own elaboration

Interactions

The search for funding/investment opportunities involve, beyond fund seekers and potential funders, other individual (e.g., experienced scientists, financial practitioners, senior non-executive managers) and organisational actors (e.g., university hubs, technology parks/campuses) in roles such as advisors, match-makers, contact facilitators, evaluators.

Funding-related interactions among the directly concerned players in the bio-pharmaceutical sector are not straightforward and easy. Sometimes, the role of a third party is essential to make interactions happen, particularly when certain
“distance” naturally exists between the owner of the project and the potential external financiers. Thus, in many cases interactions are mediated by a party that plays different roles (Table 16).

Beyond the participants and their roles, from initial cold contacts to repeated dealings with existing contacts, a number of factors and situations may get in the path of the interactions. Players, for instance, can change their mind unexpectedly or without a given reason and other new issues may become a factor to take into account. As a company manager illustrates, some issues about the engagement between potential financiers and project owners/managers can turn a prospective deal into a failed attempt to get funding from an international investor; a player, most usually a funder, can change his mind because of a number of reasons ranging from a final negative assessment of the project/company or the team to insufficient understanding of the space to changing conditions in the sector or the funding environment (Table 16).

The nature of the funder, for instance, seemingly plays a leading role in the strategy followed concerning the financial support provided to given projects. In fact, the interactions appear easier and more fluid when there is not only a certain acquaintance among the potential partners (project owner/manager and funder), but some knowledge about the sector, the type of players, the activities and other elements that supplement the financier’s criteria to select projects of interest. This knowledge and the closeness it creates helps “lubricate” the interactions.

Moreover, the fact that VC organisations are commonly staffed with managers that have a record as university professors and researchers, start-up entrepreneurs or company management/board members may facilitate the understanding and interaction among prospective funders and fundees. The recourse to informal or formal advisors, consultants or even ad hoc facilitators by a single or by both parties also tends to make interactions more fluid.

**Interactions among potential external funders regard co-investment and follow on investment. Interactions and their results may be conditioned by institutions such as regulation, State policy, and demand structure and dynamics.**

The contacts and interactions among potential funders and innovative organisations may often be conditioned by several different factors, however. Regulation, policy, demand structure and dynamic trends with a historic component (path dependency)
are some examples of conditioning issues. Take, for example, the case that several company and fund managers expose about the completely different conditions that characterise two regional bio-pharma ecosystems in the UK and the way fundee-funder interactions are impacted. Companies looking for technology or for investment opportunities in the so-called Golden Triangle (Cambridge, Oxford, London) will most probably know and go to a well-known technology transfer group (CE) which will basic match interested players up; the main point is, however, that if you are not an entrepreneur, you will likely not have heard about CE. CE operates successfully because they are a sort of matchmaker within a partnership where VC people participate actively so CE always have a first look at all the technology originating in the geographic area (at least, among the partners) and that is why they can draw interested parties together. Such is not the case in other geographic settings in the UK, such as the North-West, where such an ecosystem is not in place even if bio-pharmaceutical start-ups are budding, but local investment sources are scarce and no thick entrepreneurial and business networks in the space exist. Similar examples can be mentioned for the space in some geographical areas of the US (e.g., Boston and San Diego), Denmark (e.g., Copenhagen), France and Germany (Table 16).

Moreover, some other times interactions that should proceed smoothly are turned into bumpy procedures because of external factors that get in the way. This is not uncommon in the case of co-investing, for instance, and regards not only the differences among investors, but also the institutional conditions under which such interactions are shaped. In some cases, for instance, specific regulation becomes a key factor because differences in taxation rules or protections offered to the investors. Though surmountable, such differences do make coordination procedures difficult in the case of co-investors with partially divergent expectations and rights.

Finally, interactions among the different actors are also impacted by the changing trends that make the players’ roles evolve according to the emerging realities in the sector; the growing involvement of big pharmaceutical companies in early stage financing, for instance, tends to make life easier for bio-tech start-up entrepreneurs and many other early stage investors because licensing and trade sale exits seem more plausible. Late stage investors, however, may find it slightly disrupting as it means greater competition for mature projects once the proof of concept threshold is overcome. Also, big phamas now increasingly face challenges even around
production and manufacturing, so they come more often to academia and try to find solutions they do not have the resources to generate themselves.

Table 16 - Interactions – excerpts from interviews

<table>
<thead>
<tr>
<th>INTERVIEWEES</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
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<td>... so we chased around and I knew a few of them anyway from the previous life and I'd been involved putting a company on AIM... so we went around and it is a painful process because getting people who specialise in your size of company, early stage at that point, there are not many of them...</td>
<td>Not a combination [of fund raising]. What I do is... I don't raise funds... I only raise them when I need them. And when I do raise them, I do them very unusually because I go straight to the market and I do it over a couple of days. It's very unusual what I do and because of this strength of support, when I do it I get the timing. The timing has a big bearing on it as well.</td>
<td>... that was an American investor who had a UK-based agent who came across our technology and got us all the way to signing a memorandum of investment with the American company, but on the morning that the three partners were due to sign, they decided that it was not the right investment for them. So it seemed very easy until the last second or last hour, which I then became so happy that it did not happen.</td>
<td>Most investors are not interested in the history of a company. No historical viewpoint is taken into account and this is a disadvantage. They are essentially interested in the quality of the project, the science, and the potential market and the profits, but they do not consider the efforts realised by the founders previously.</td>
<td>... when you are looking for funding it is not to tell about what you've got, it is where you are going to be and how you are going to get there.</td>
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<td>So the challenge is always that you've got investors that are coming at an early stage and don't have the ability to follow on the investments, then you run into all of the risks of dilution. Certainly that is likely to be more problematic if you've got Angel investment or you've got a significant number of high net worth individuals who have invested in the business and, therefore, you've got to manage that collective group when you are looking to bring in further investment; so that is undoubtedly problematic.</td>
<td>Investors will look at a whole range of things when making investment decisions. These include (but are not limited to) the strength of the science, the possible market opportunity, the therapeutic area the product seeks to address and also the strength of the Intellectual Property.</td>
<td>... most of life science investors know each other, they manoeuvre between investor capital, so... Lots of people would not syndicate because they do not play the game right... But essentially there is always a lead investor and then the co-investors, the lead investor essentially manages the deal and the co-investors just put the money. So, in terms of that, that mitigates a relationship for a lot of people at the table are saying different things for the same amount of sales, so that is that.</td>
<td>Also, VC funds normally prefer to co-invest alongside an institution, rather than with business angels, due to the similarity of mentality and depth of pockets to follow on investments. One problem associated to co-investment with business angels is that when the second round comes along, business angels may not necessarily be able to follow their money, so the weight of the funding requirements will fall on you and your fund.</td>
<td>The trends in the biosciences industry, including the large capital requirements, have also pushed Pan-European and global investors playing in the US and Europe to syndicate funding. So in the bio-pharmaceutical sector you can see both a competitive business where they try to beat their peers, but also a set of people that co-invest on a regular basis because they have to. So a lot of deal flow comes from the networking among investors.</td>
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<td>Interaction between the fund and potential start-ups is much more intense under this programme since...</td>
<td>One of the reasons that we focus on the Golden Triangle is our policies are more keen about investing very early, so we are predominantly reactive, although we do a little scouting. But, again I would point to our unique...</td>
<td>... if you bring in small investors, you know, they have a different agenda. And it becomes very difficult to manage...</td>
<td>We definitely prefer to co-invest with venture funds but we have co-invested with all those different categories [BAs],...</td>
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most "companies" do not have a full business plan, but just an idea. The relation with them starts with helping them to shape the idea into a business plan if the fund believes the idea is worthy and the people behind that idea are ready to be helped. Unlike most VC funds, SI invests more than 2 days with each "company" to develop the support process...

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<td>... So, what you do at the first meeting is you try to understand if you like each other; if you do, then you establish a dialogue and then you also still [wonder] &quot;ok, can we actually work together after this potential investment?&quot; So it is more this dialogue that needs to actually be very smooth and you need to show also that you can make some decisions that might actually go against what they think is a good decision... So they are, of course, also testing you, if you are able to make some decisions.</td>
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In all cases we approached them, at least initially, yeah... and I think that when you start with an idea and no results, it has to be that way because they will not be sitting and waiting, they will not be scouting for just ideas, they will be scouting for results. So we, we tend not to co-invest with business angels because they rarely can follow on and particularly in life sciences. So, we do like co-investing simply because it means that, you know, if you look at a typical med-tech opportunity, you... it would not be unusual for your first round to be half a million and then another one and a half million pounds to get to see the market and then two or three millions for launch... we are not going to do that on our own and, then, by having co-investors we can come in early...

... and also investing together because you see the same class of share in a way, whereas if you go through different rounds of investing, you know, you might end up with A, B, C, D shares... you know, it is a nightmare because you have different preference rights and it gets very complicated.

In fact, we actually will help support groups of universities and research organisations to develop these partnerships as part of the European Frameworks and so on that are going on. They are hugely increasing in importance and we very much work with that...

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<td>We can invest in Nordic countries, so that is Denmark, Norway, Sweden and Finland... and Iceland. [investing outside this geographic area], that is a different department. That is not NNN but MMM, which is... we are all part of NNF, which is the holding company, but we are different</td>
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You are more comfortable with co-investor with whom you have worked well in the past and you tend to find that co-investors do... are serial co-investors. So, for instance, we have three or four companies where we have got the same co-investors each time and we, you know, they... are the same |

We syndicate a lot less today than we did ten... five to ten years ago. And the main reason initially was actually just the sort of shake out in the market. And where we were involved in heavily syndicated deals, we started to have to deal with the challenge of having co-investors who no longer had any funds |

Yeah, it is more usual to have co-investment, even today, that's for sure. Why is that? Because... you never know when companies will need more funds and it is always better to have deeper pockets to be able to overcome the ups and downs of a project successes and failures... and these |

We like to lead and we have a group of other firms that are willing to look at early stage deals that... you know, we have worked with before that we invite to look at deals we are leading. And, you know, that has not been a problem to find... other folks to invest although it is one where, you know,
Availability of sources and mechanisms of finance

Innovation funding is essentially impacted by the availability of sources and mechanisms of finance in a local, regional and national context. Innovation finance is essentially high-risk acceptant and should possess either a certain knowledge of the science/technology behind the projects or the channels (network contacts) to acquire such a knowledge. This is directly related to the “limited
research space mastery” that firms exhibit due to the ever expanding knowledge base in the industry.

The actual availability of funding to support innovative companies is rather narrow if compared to the wide theoretical arrange of possibilities. In fact, when it comes to internal funds, obviously pre-revenue companies (such as many start-ups) and even established companies with limited revenue are at a disadvantage. Then, concerning external funding, the options are in fact restrained by a number of factors.

Commercial banks are not usually an option to fund innovation because they are not risk-takers; their business opportunities lie somewhere else. In fact, some managers acknowledge that their companies have more or less regularly tried the loan option with a number of different banks, but these are usually resistant to offer any money. In one case, for example, only at the third attempt a company was offered one hundred thousand pounds by one bank in the UK. Yet, the managers do feel that it is understandable in terms of risk; it makes sense because if the banks lend money, they want it paid back and, given the characteristics of the prospective loan takers, their reluctance is understandable to an extent. This seems to be a common view among firm managers; in fact, most company managers confirm the reasons behind the inexistent role of the banking sector: the banks are too expensive for pre-revenue firms and even for early revenue-generating start-ups and they are not ready to fund such companies because these are not considered a safe investment given the absence or weakness of revenue streams and profits and their associated risk (Table 17).

This, nevertheless, entails the possibility that once small bio-pharma companies jump forward steadily and are seen by commercial banks as established businesses able to generate sizable profits, indicating a “sensible return on the business model”, so that they can cover interest and own valuable tangible assets to be used as collateral, they can be considered to enter loan positions.

The matter for commercial banks is in fact all about taking the lowest risk possible and having a guarantee that they will recover their money. That is, banks are incompatible with two key characteristics of innovative firms/projects in the bio-pharmaceutical space: high risk, intangible assets (hence, no collateral). The only type of banks that do get involved in helping bio-pharmaceutical star-ups get funding are investment banks or bank branches that can be hired by such companies to
contact prospective funders and raise financing on their behalf in exchange for a fee which is usually equivalent to a standard percentage of the funds raised (Table 17).

Table 17 – Availability of funding – excerpts from interviews

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<td>I think the people in the government are interested in the space and they work hard in conjunction with the biotech industry association and the association of the British pharmaceutical industry... I think they work hard to try and get a bit of financial support, recognising that it is very difficult for start-up companies...</td>
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<td>... in theory, all of these [sources] can provide funding, but very few of them would without a track record, an understanding of the management team, a clear business plan, the right return... ... the risk model for what we do is not a model that the bank would lend to. Until you’re generating high bottom line profit and there is a sensible return on that business model, a bank is rarely going to take the risk of giving you any loan position.</td>
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<td>It's relatively easy to get money from grant funding, but there's uncertainty and there are... will the government fund me or not is a big question... the uncertainty is the problem. The second problem is the time that it takes...</td>
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<td>Funds have been obtained essentially from different government programmes and sources.</td>
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<td>Our personal experience of AIM was that it was a very hard place to be when you are an early stage technology company... is being a listed company the right thing to do when your early technology is so tentative and precious...</td>
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<td>... typically, angel investors are not going to put in the volume of money that is needed for pharma and bio-pharma. The projects I’ve seen angel investment on have been medical technologies and things relating to maybe medical education and that kind of... so healthcare related, but perhaps not sort of the high tech stuff.</td>
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<td>In terms of the public money, I am a very big fan of public money in bio-pharma because otherwise there wouldn’t be anything yet funded. Right now I have two bio-pharma deals with public money that are now going into raising significant amounts of money and that... if they had not raised the public money, they would still be out there raising money. And I think the way to do that is to have focused funds on... it is not to have generalist funds, but to have focused funds where the investors understand the technologies quite</td>
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<td>This can be quite an issue because the management is continually fund-raising rather than managing the business. This may also reflect the fact that there is not that much early-stage funding in the UK market. What funding there is, it is primarily business angel or small university funds and it’s a bit like herding cats. Because there is such a big diversity of funding sources in the beginning, it makes it difficult when institutions get involved because you have to take account of the multitude of shareholders.</td>
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... in the biopharmaceutical area they will be looking for various forms of grant funding, and seemingly companies either are getting that through organisations like the Technology Strategy Board... so, they are not going to get that through banks and they are not going to get that through angel networks, so they’ll be looking at a variety of options of which venture capital will be one element.

... in theory, all of these [sources] can provide funding, but very few of them would without a track record, an understanding of the management team, a clear business plan, the right return... ... the risk model for what we do is not a model that the bank would lend to. Until you’re generating high bottom line profit and there is a sensible return on that business model, a bank is rarely going to take the risk of giving you any loan position.

This is changing with a greater mix of now available as the traditional source of Venture Capital has become harder to come by. There are now a reduced number of VCs investing in life sciences and bioscience in particular (although this may be picking up), and these VCs tend to be specialist investors rather than generalists. Bioscience companies now look to a wider range of funding opportunities to support their business. These include medical research charities, in terms of the public money, I am a very big fan of public money in bio-pharma because otherwise there wouldn’t be anything yet funded. Right now I have two bio-pharma deals with public money that are now going into raising significant amounts of money and that... if they had not raised the public money, they would still be out there raising money. And I think the way to do that is to have focused funds on... it is not to have generalist funds, but to have focused funds where the investors understand the technologies quite

This can be quite an issue because the management is continually fund-raising rather than managing the business. This may also reflect the fact that there is not that much early-stage funding in the UK market. What funding there is, it is primarily business angel or small university funds and it’s a bit like herding cats. Because there is such a big diversity of funding sources in the beginning, it makes it difficult when institutions get involved because you have to take account of the multitude of shareholders.

No two VCs are alike and, for example, early stage means different things to different people even if there are statistics that say that it is going to be the same across the sector.
Corporate Venture Capital arms (equity investment arms of large biopharmaceutical companies) and government grants.

intimately, where the investors are incentivised to put money out...

[Public money does have a certification effect] to an extent, I mean you cannot place too much weight on it, but to an extent it shows that it is a good signal and allows the company to prove itself...

... Because we operate at quite early stage, we do see and we do encourage our companies to apply for grants and for funding that might be available to them by other sources...

I think, unfortunately, in early stage life science, it is hard to make the projects survive without some kind of government support.

... the problem there is that there are just not the investors around to get sufficient cash and when you are public, you know, you are always fighting the investors about the progress that companies are making. And because it is not a very sophisticated market, I think companies struggle on AIM.

... biotech companies that use something like AIM, they are usually going there because they have had a hard time finding any other financing. At least at the price they are interested in. And, as a consequence, they tend to be too small and they don’t tend to be so liquid.

I have been involved in several projects where we have government money and also EU grants. I think it is a great way of raising money for developing companies.

The private investments that we have is from our own sort of investment, private investment... we have put into the company our own money, both Prof. XXX and I, we have put in smaller amounts, not big amounts, but smaller amounts to get things going, and get the first test results and so on.

We are a venture capital company listed on the XXX and we specialise in early space technology and particularly technologies that come out of the universities, so the way our model works is that we have a relationship... formal relationships through partnership agreements with a number of universities around the UK... Most of our investments go through the universities we have levels of exclusive access to their IP.

There are quite a lot of... well, not that many funds that do early stage investing. I suppose the reason for doing that is that if you are going to fund something really disruptive then you kind of want to be the first to get it because you get the most of the value.

So we go... we, across Scandinavia we have a pretty good reputation of being a very reputable investor, so a lot of people contact us directly; we also read scientific papers and try to identify opportunities, go out and give talks at universities, tech transfer offices, and so forth. And then, we have a special programme here at NNN, it is a grant programme basically, that reaches into universities where professors and principal investigators can apply for grants and...

Well, two things at least come to mind. One is that this shortage of capital to invest in the early stage, especially the very early stage area... so actually if you are a fund just like ours, we get approached a lot, we get approached in an unsolicited manner; in other words, people come to us because they hear we’ve got, potentially we’ve got some money... people come to us, so that is one thing...

I would suggest that over the last five to ten years the actual amount of venture capital funds available to new companies have... there is kind of a whole range of it, but... you know... let me just contrast two different types of venture capitalists... there are a lot of Hmm... [it is] very difficult to operate a company on these grants; there’s two phases to those grants: phase one is typically very small in I think there is an evolution as the... bio-tech CEO; you know, early on you really tried to... the friends and family kind of as the original From two million to twenty million, I think, venture capital is... really disappointing. The only place to get it for a company that does
diminished, you know, have reduced. There's been a change in the mix of available funds, and what I mean by that is that there's been an increase in the amount of money coming from corporate venture capital funds…

different types, but in bio-tech some people are very anxious to invest only in late stage drug development; they want products that are in late stage clinical trials, they are often investing in, you know, c, d, e, f, g, h, j rounds and their deal flow, you know, is sort of… inevitably comes from other venture capitalists, from entrepreneurs that are trying to do another round of funding for an existing company. We are at the other end of the spectrum; we do a little bit of that, and so we've been successful with late stage companies, but I think that our special niche is with early companies…

the order of five hundred thousand to seven and fifty thousand and that is enough to do a proof of concept; if you are successful with that, you can apply for a phase two, that can be up to three million dollars… And, of course, the traditional approach is the use of venture capital money… and there you really have to have a strong network and…

venture capitalists. Then, as you spend out and start using, you know, maybe some smaller bio-tech banks… so, you know, the web pushes. That starts broadening your horizons and that brings you to perhaps a wider audience.

not have revenues… You know, less than that you can get it from angel investing and then more than that, you actually go to other financing, like public financing.

Note: A longer table with further excerpts from the interviewees' statements can be found on Appendix 1.

Source: Author's own elaboration

A growing option that seems promising in other fields seems also effectively discarded in the bio-pharmaceutical space. Though potentially interesting, crowd funding raises other concerns among funders, especially VCs and angels, knowingly the risk of ownership dilution. This completely or nearly rules out the possibilities of over-the-counter (OTC) funding that includes other so-called informal sources and mechanisms of funding: founders, family members, friends and “fools” (also referred to in the literature as the four Fs). In fact, in most cases these four potential sources are completely out of the picture in the bio-pharmaceutical sector mostly because of the pocket depth (the amount of funds) needed and because if other financiers appear, namely formal ones, some conflict is bound to appear regarding the eventual appropriation of IPRs and profit if the project is successful, not to talk about ownership dilution once again.

Nonetheless, other reasons are also spotted that are more related to a sort of moral consideration regarding the risk entailed in connection with the lack of resources from the founder himself. Some entrepreneurs, though blindly faithful about their projects to the point of giving up privileged positions in universities or other well-
known companies in the space, feel it can be morally unacceptable to ask close individuals to jeopardise their money in highly risky ventures.

More promising options lie with government funding and formal private equity investment. Despite the fact that government funding and VC funding have different strategic reasons, according to most company managers, both sources are essential for bio-pharma when it comes to innovative SMEs and start-ups. However, it is not a straightforward procedure. In fact, two important issues are raised by most firm managers according to their experience: uncertainty about getting the funding, and time. Uncertainty is mostly related to the attractiveness of the projects to an unknown jury (as the projects are usually judged on the basis of their intrinsic quality mostly) and time has to do with the lengthy application procedure and the multi-month lapse that is usually necessary to effectively receive the money granted.

In fact, according to the experience of some managers, a number of internal and external circumstances may condition the usage of any of these sources. In some cases, for instance, managers think stage awareness concerning their innovative activities is a factor to decide where to apply for the necessary funding. In the case of early stage projects, such as the case of pre-proof of concept technologies, government financing is highly desirable; yet, if the stage is beyond basic research and more into development and production, such as the case of pre-market technologies, private financing comes handier (Table 17).

In other cases, however, such preferences may be modified by the feeling that the whole macro scene is absolutely relevant. At some point, for instance, academic researchers in some European settings such as the UK academic researchers looking for very early and early stage financing may perceive that grant funding has nearly dried out so the odds are very much against them.

Another relevant issue, however, is raised by some VC fund managers; the main difference between financiers is that government-sponsored funds are more willing to take risk than the commercial (the so-called “tax efficient”) funds. And the “tax efficient” funds can take more risk than the fully commercial funds if fully commercial funds in the early stage biotech space exist at all, particularly in settings such as the UK.
Beyond any differences whatsoever, the role of State funding is clearly recognised as vital for the industry, particularly in what regards SMEs and start-ups in most national settings, as the representative of one of the biggest industry associations proclaims. In the UK, for instance, the Biomedical Catalyst (BMC) running since 2012 provides non-diluting funding to innovative firms in order to support project development. This mechanism has proved valuable and successful also because it has helped leverage significant additional private funding.

Another funding option, which is not available to all innovative SMEs, lies in universities and, growingly, in charities. Clearly, the first one is an alternative for university-born projects/firms (spin-outs) that are usually based on the research carried out by university staff. Universities in different national settings often provide small seed capital and regularly make an effort to bring other investors into the ventures. Many universities use such limited funds to support very early stage activity in pre-company settings such as basic research until the proof of concept stage and in some cases may even support projects through market studies with the involvement of the industry with the expectation to attract larger funding in order to move a project forward. That can be quite an effective mechanism to get funding partners involved in the early stage.

Actually, VC managers are usually aware of this and some are often ready to play the game. VCs, in fact, may look to co-invest with universities because that is a way to explore the value of an early stage project and, if deemed scientifically worthy of further investment, to help “crystallise” a good investment opportunity before any other investor spots it.

As for charities, they seem to be interested in finding a space where their money supports their “voice”. Moreover, company managers think that the financial involvement of charities may be advantageous in some sense; they bring in the capabilities of some seasoned managers that can help the organisations, especially if they are novel, in order to comply with milestones and meet deadlines that are usually required by investors and become thus key for innovators to go through fund raising cycles.

The importance of charity funding in some environments is reflected in the fact that UK medical research charities currently invest over one billion pounds per year to
support medical R&D in the country. This is, nonetheless, not the case in other settings such as the US or Denmark.

Finally, the most characteristic funding option of market-based systems, namely the stock exchange, works diversely in different settings. While it works rather smoothly in the US both in its standard version (the NYSE) and its specialised branch (the NASDAQ), it seems to falter in the case of the UK (where there are also two versions: the LSE and the AIM) and Denmark (where only the standard stock exchange -CSE- exists), for instance. In fact, the stock market is usually assumed to be the best option for a company to raise funds provided that certain requirements are met. However, it is a costly and long process according to the experience of several managers. That is why floating a company in the stock market is a strategic decision that concerns both the company and its funders.

However, floating a company is such a difficult and complex process that in many cases companies plainly do not succeed at it and some others even get bought while still in the process to get listed. The main issue to be understood here is that getting to a flotation successfully does not only depend on the company, but also on the conditions of the market. In many cases, even if the firms comply with all the requirements, the market conditions may become so rough and even adverse that the process ends up failing, sometimes more than once.

Then, a company may succeed at getting listed, but the flotation does not guarantee the exit of the original investors as, depending on the conditions around the IPO, the investors may end up buying at least some of the shares to sell them later in the secondary market in order to cash and get back the funds invested. Thus, the difficulties entailed by IPOs have growingly become an issue regarding the real exit possibilities for bio-pharma investors and the successful realisation of profits. In fact, some funders and firm managers confirm that in many cases the exit strategy is essentially limited to sales and acquisitions or, when possible, management buy-outs.

That notwithstanding, listing in the stock market can also be used as a strategic move to lever a different kind of funding support, as described by some company managers. In some cases, the flotation itself may be successful because it is the result of a company being acquired or merged by a bigger firm which is already listed (a sort of “reverse flotation” as some managers call it). However, in some national
settings listing is hardly an option because the market is not very large and open and, furthermore, because the bio-pharmaceutical sector is not well-known and attractive enough for potential investors, as the case may be in Denmark or even in some regions of the US and the UK, outside those specific geographical areas where the industry is concentrated.

So, seemingly, the usage of the various available sources and mechanisms of funding is embedded into wider strategic considerations that have to do with the reasons of fundees and funders, and with external factors that have an impact on the decisions to look for funds (on the side of innovative companies) and to place funds (on the side of investors).

The lesser availability of funding sources for innovative bio-pharma companies in certain national settings may also be related to the way in which financing is structured. A funder considers that in this sector deals, even the early stage deals, tend to be syndicated more and more. Nowadays, investment syndication is conceivable from day one even if more than one round of funding is needed. In fact, co-investment seems to always be the best option because, given the uncertain, risky and long-term nature of bio-tech innovation, there will always be need for additional rounds of funding regardless of what the management team can tell and particularly because quite plausibly at least one co-investor will fall away sooner or later.

**Investors’ characteristics**

Also, some key investors’ traits have an impact on the strategic approach to funding innovation.

Five specific characteristics of VC operators seem to affect their investment strategic approach to the bio-pharmaceutical sector in the UK. Those factors are, in short: source and size of investment funds, investment horizon and timing, investment structure, preferred stage for investment, preferred exit mode (Table 18).

- The investor base (IB) (that is, the original source of the funds, be it the State or private companies, individuals or other organisations) may direct and sometimes restrain investments (government-funded gap VCs vs independent or corporate VCs, for instance). In other cases, even in the absence of sources’ constraints, the size of the funding available (the “pocket depth”) and
even the team size may become a huge factor, particularly if the VC investor has to split its resources across a portfolio of different sector projects/firms (generalist investor risk diversification).

The origin of funds on its own can certainly make a difference when certain trends are taken in account, as remarked by an investor. Private money, with very few exceptions (e.g., business angels and some particular VC funds) is not interested in any very early (pre-proof of concept) to early (pre-organisation) stages so government money (e.g., grants) are nearly the only financing available to do lead candidate development.

But also fund size (pocket depth) related to team size involves different challenges that usually end up affecting the deal flow. In the words of a senior investor: “one of the constraints when you are a VC is how big the fund is, how many people you’ve got, so how many deals you going to do [in] a year.” (I 10) These issues are likely to complement the funder’s strategic approach to investing in a specific sector: that is, being a generalist investor with only a marginal interest in the projects/companies of a given sector such as bio-pharma or being a specialised investor in a space/sub-space and having a network of connections able to supply both deal flow and knowledge to strengthen the investment activity.

Thus, the investment base and related pocket depth and team size factors may add to a compound approach where strategy involves more than a simple choice of projects. The investment management team, their knowledge and skills, the appropriate pocket depth to negotiate the different funding rounds, the adequate timing, these are all essential factors that make the difference for the potential limited partners of a funder, particularly of VC funds.

- The time horizon and timing for investment (ITH&T) is a factor to take into account, as well. The investment horizons are usually determined by the sources of the funds (IB) or by the VC organisation management; these “time windows” are artificial in length as long as they are not necessarily based on the time framework of a specific project, firm or industry. Often, VCs want to recover their investment and the corresponding profit within a time span that is usually shorter than the time horizon necessary to fully develop bio-pharma
projects; that is why it is desirable that “there are VCs in just at the right time but equally it is important to get the stake in the ground.” (I 8) Thus, time horizon mismatches between funders’ and projects’ cycles may also heavily condition investment decision making by VCs.

This may be related to the appropriate timing of investment entrance and exit; when is it the best time to enter and exit an investment opportunity does not depend only on the characteristics of the project/company or the wants of the investor, but a number of macro and micro contextual factors are also at play and may change the whole picture in a short time span. Timing, for instance, can be manipulated to a certain extent by using shorter term funding with follow on money conditioned on the results obtained.

Alluring short-term pre-seed and seed capital can help “crystallise” an attractive investment opportunity in the sense that it may help clarify the real potential of an innovative project in order to decide if it is worth going forward or not. Later on, if the results are positive, the funder may decide to proceed to finance a further round on its own or to create a syndicate of co-investors depending on the characteristics of the fund itself.

Of course, the time horizon and timing are also influenced by investment base-related issues (e.g., “pocket depth”) and may, in turn, have an impact on the investment structure in terms of following the money through different investment rounds and the final distribution of property rights. Actually, the number of financing rounds, the number and type of co-investors participating since the beginning or entering the project in later stages imply different expectations in terms of IPRs entitlement and dilution risk.

- A third factor is investment structure (IS). Co-investing, an increasingly important modality that involves a number of funders of a different nature (e.g., State-sourced and private, corporate and independent, VCs and BAs), may be a big factor when there is a wide range of investors’ objectives, time horizons, expectations, and “pocket depth”. In particular, BAs and VCs and publicly and privately sourced investments seem to present the higher variations concerning the bio-pharmaceutical sector and this may be a huge factor when follow on funding is necessary.
The existence of a lead investor, with specific responsibilities (the lead investor essentially manages the deal, including the due diligence, whilst the co-investors just put money in), all along the life of a project and the plausible need for secondary investors who may stay in all the way or exit at some point before the end, thus forcing changes in the structure of the syndicate, may have different implications in every single case. This is anyway a mechanism to de-risk the project by sharing the risk and to enhance the networking within an industry.

IS also involves resourcing to State-sourced funds and grants of different types, at least at the beginning, so that the dilution risk is lowered and the value of the project is increased by taking the project as far ahead as possible before VC or Angel money gets on board.

Of course, as suggested earlier, the more funders invest smaller amounts of capital, the less risk each investor faces. That, however, entails a greater dilution of property rights and, consequently, of profits. That is why non-diluting financing such as government and charity grants are advantageous and may also serve as a signal of the “soundness” of a project in order to allure bigger funders such as VCs.

Furthermore, IS also helps modulate ITH&H by establishing short-to-mid term challenges (milestones) so that the risky and uncertain nature of bio-pharma projects can be better dealt with. This will make investors feel more comfortable and keep the doors open for new investors to enter as eventually and almost inevitably one or two secondary co-investors will drop away.

Also, investors’ affinities may turn up and facilitate the structuring of the whole operation; normally, investors tranche their funding around milestones to help create greater clarity for subsequent funding decisions. Usually, only a third or so of their funding capacity (pocket depth) is compromised at the beginning.

On the other hand, they prefer to co-invest with similar financiers, particularly if we are discussing VCs, as syndicating with other types of funders (e.g., business angels) implies differences of mentality, pocket depth, time horizon, and expectations that may affect (e.g. enhance, collide with) the
responsibilities and expectations of lead investors and, in general, first round financiers.

The dynamics of the relations among investors is, thus, complex and based on a number of organisational internal and external factors: competition for deals versus syndication, early versus late deal stage, types of financiers taking part (BAs versus VCs, state-funded versus privately-funded, corporate versus independent), diluting versus non-diluting funding.

- Fourthly, the *preferred stage for investment* (PSI) becomes a highly relevant factor. Not only because of the reported differences between early-stage and late-stage investment, but because “early-stage” may have different meanings, particularly in a sector such as bio-pharma. In fact, the literature usually considers “early-stage” any of the pre-market stages between pre-clinical and clinical trial 3 or even pre-registration (for formal approval); yet, some investors consider early stage the very inception stage when a discovery or innovative idea has just “come across the innovator’s mind”. Moreover, some VC investors seem to be growingly specialised in throwing money and advisory in at such an early stage in order to “crystallise” investment options more easily and to de-risk ventures as revealing dead-ends early in research may help save valuable resources by killing non-promising projects before further resources are spent unnecessarily.

Stage preferences are also connected to the timing of the investment. This can help explain the differences in the strategic approach by different types of investors; VC and company senior managers point out that corporate funding of early stage projects/companies has been growing steadily in the biopharmaceutical space under both modalities: stand alone and syndicates operations.

On the other hand, as has been remarked previously, government funding initiatives usually concentrate in early stages which, for many bio-pharma start-ups facing difficulties to attract VC and even BA financing, means a real life line.

Stage preferences for investment generally imply a trade off in terms of uncertainty/risk and price/expected returns. A shorter ITH means greater
proximity to the market and earlier revenues comparatively, but it also implies a greater cost of the entry investment ticket and, accordingly, lower profit rates.

- Finally, and concurrently with the investment horizon, the *preferred exit mode* (PEM) plays an important role in setting up the investor’s strategy. Although theoretically there are several options, VC investors’ exit in bio-pharma are particularly concentrated in corporate buy-outs and M&As, selling out to another independent investor, management buy-ins and IPOs. The exit mode is usually conditioned by the investor’s time horizon and the investment structure, particularly when a variety of other investors are present.

Some exit modes are preferred over others in different national contexts and their popularity may change over time due to shifting conditions and according to the short-to-medium term results reached (milestones). IPOs, for instance, are more usual in the US than in the UK; on the other hand, many European ventures seek to license (selling the right to develop the drugs or products further), which is a way to shorten the long time scale, or to trade sell the venture which means also avoiding the potential trouble of acquiring the capabilities necessary to take the technology or product to the market (something particularly demanding for an inexperienced company). In most cases trade sales involve a big international pharmaceutical firm, happy to replenish its pipelines, because that means a “sexy” world-class deal that enhances the track record of venture entrepreneurs and financiers alike.

In national settings such as the UK and Denmark, both venture owners and investors in general agree that trade sales are preferable over IPOs due to a number of reasons, from past delusional stock market performance (even in the case of technological markets such as AIM) to the risk of temporary lock-in of investors’ funds due to usual stock price instability following flotation. This opinion, which affects the funding strategy, is summed up by a senior investor’s words: “*if you are building stuff that people do want... then you need to build the company in such a way that it is very easy to get acquired, not that is very easy to float.*” (I 8)
Actually, this viewpoint seems to be widely extended and brings under the spotlight the underlying difficulties of growing bio-pharmaceutical companies in the European context where a single country is not considered a big enough market -either in terms of products, technologies or firms- so that start-ups and even established small companies are usually developed with an acquisition event in mind especially by a big company, preferably an American one, or to be floated later in the US stock market.

Exit, as mentioned earlier, is also conditioned by timing related to market conditions (external factors) and other contextual external and internal issues (e.g., industry trends, economic and financial conditions, co-investment agreements) that may complicate things further for investors. For instance, a fund that realised six IPOs within its portfolio was left locked in for some time; when they were able to sell the shares later, they got a share price lower than the flotation price and, to make things even worse, that happened when the fund was coming to the end of its life thus creating a particularly difficult situation to the VC fund managers concerning their limited partners (the investment base).

A particularly illustrative example where most of the features described above play a significant role can be embodied by comparing the situation of the gap VC fund fed with European money to a normal VC fund investing the capital of its limited partners and, finally, to a corporate VC fund. The State-funded gap VC fund has enough pocket depth and a large enough team to comply with the goals established; in that it may compare to any independent or even a corporate VC fund. However, stock listed funds or funds embedded in a larger organisation (usually huge foundations that set up a family of funds that cover every stage and type of funding possible from pre-seed grants to private equity investment) not only have deeper pockets but also a structure that guarantees virtually no barriers to follow on funding, which means basically no time horizon restrictions.
Table 18 – Investors’ characteristics – excerpts from interviews

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<th>INTERVIEWEES</th>
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<td>So whether there is an up round or down round depends upon the quality of the company, how well it’s done, and whether the VC is prepared to actually then invest behind it. So there’s a lot of mechanics to some extent and strategy around the way in which each funding, each investor decides to position themselves.</td>
<td>Because it’s likely to be a natural part of the strategy to realise the profits on their investment, then they would probably like to be quite hands-on. If the ability to get profit on their investment will be dependent on whether they sell out the business at the appropriate time, to the appropriate party, they are likely to be very heavily involved in that part of the process.</td>
<td>For follow on rounds, I would say almost every investor who does early stage biotech, a serious investor would do follow on unless there is some strategic issue why they cannot so things are taking so long and the follow on is too late and the fund could not raise it … you know, funds are constituted for 10 years, they have 5 years investment, 5 years realisation… if they invest into discovery at year 5 and now it has taken longer than expected and it is year 8, it is just about going to phase 2, maybe I would not follow on because then the investors would go for another one… maybe they would. Follow on is key here. It can also bring a new investor around, but essentially it is not about that.</td>
<td>Regarding investment horizons, the timing is essential for funds. The funds PG has worked for usually invest for five years before exit, which for bio-tech is the wrong model. Now, as for venture capital trusts (VCTs) (a tax-efficient vehicle open to the general public usually managed by commercial operators), they probably embody the best model to invest in bio-tech. They raise money from the general public, they have tax advantages, and they destine their moneys to SMEs.</td>
<td>Investment time horizons tend to be also fund-specific. In technology industries (including therapeutics), perhaps with the exception of software-type businesses, if you are an early stage investor, your time horizon should be five to seven years. This is pretty challenging when you are in a ten year fund because it leaves you no leeway. A ten year limited liability sort of vehicle is quite hard to make work for if you are going to do C-stage (clinical) therapeutic type deals. Now early stage can mean as early as creating the company (meaning institutional angel money) and that is really hard in the biopharmaceutical sector because seed funds do not tend to be large by nature since, given the amount of rounds and the amount of money that it takes even if you create a successful business, you can end up not crystallizing a great investment return given the time and preferences that you can alternatively use the money in. That is why if you are not a dedicated seed fund, exposure to life sciences would not tend to be in the full in therapeutics.</td>
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<td>SI is a provider of “Gap Funding” which means that it is not allowed, by European mandate, to invest in firms if companies are able to raise money somewhere else. In a couple of cases, companies have used the fund offer to</td>
<td>I guess most of our historical companies that we’ve exited were exited by trade sale and most of the companies that we are building at the moment we have targeted to exiting by trade sale. I guess our position is shifting slightly at the</td>
<td>We have that capability [to fund since a very early stage and to fund successive stages] which is also quite unique for the N Fund structure… that we can actually take research from the whole part of the chain here. The NN… all of our funds, in common with many venture capital groups, are 10 year funds. So, in principle, that puts a cap on the holding period…</td>
<td>… the way that we operate is that we tend to invest in a new</td>
<td>… we are being measured on an IRR perspective. So, in principle we need to be yielding more returns on the limited partner that we have, which is the foundation, that are greater than if they put the money in the bank or if they put</td>
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leverage funding from other sources and the fund has not invested any money in such companies.

moment because fairly in the healthcare space and definitely in the US there is a more active public market. And so one or two of our businesses that are more mature may seem to go an IPO route, but they have not been built with that in mind, but with a trade sale in mind.

Foundation gives out basic research grants; we have the support of the two varieties of support and pre-seed grants. We get about, let us say in round numbers, 100 support and pre-seed grants applications every year and approximately 15 to 20 of those are actually funded, so that is quite a high percentage.

Fund over the first 4 to 5 years of the life of the fund. And then we like to think of an exit in the 3 to 4 years' time frame.

the money in the hands of a financial manager, which is a question here as well. So from that perspective, time matters even if we are an evergreen investor in the sense that it is possible for us to stay an investor forever; it still has to make sense from a perspective of what the cost of money every year is.

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<td>So, we don’t have a formal investment horizon because we invest in sort of a balance sheet, so we don’t have a fund that has a need to time if you like. We have... we also have other funds that we manage effectively through... so, for instance, we have just raised a million pounds venture funding for a year with an investment bank which invests alongside us, which gives us effectively more capital power to follow on. So, that also means that we are not hamstrung by our later businesses which are burning a lot of cash.</td>
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<td>... historically, the bulk of our exits have come from trade acquisition... and I think that is probably likely to remain the case; however it is our experience that if we can develop companies to the point of, you know, getting their own commercial independence that they could... that they could potentially float at some point, then that is just more likely to make... I mean, keep your options open and then make them more attractive to a trade... trade acquirer. I think it is a little dangerous just...</td>
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<td>The... late stage investing, particularly in the last few years, there’s been a rush to late stage and so... there you have to invest a lot of money, because those are expensive clinical trials, and it has so many venture capitalists focused on it... there is... there is some competition to get into those deals and the prices are high; and... so your likely return is going to be diminished to some extent by the fact that you are paying a premium to get into a... much sought after area. On the early stage side, Well, my company invests... we specialise in very early and early stage. So that means from companies that have even not been formed yet... so with the goal of setting the company up, to the companies that are in R&amp;D product development stage. We have a few late stage companies in our portfolio, probably about five and which we originally invested in early and they’ve grown until now to late stage. But generally, when we come in, we invest early.</td>
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<td>Mostly is it [113] to get an exit in about three to five years from the initial investment. The reason for that is that is about the cycle of... when they raising a new fund. It is really important for an entrepreneur to understand where in the fund cycle an investment is coming out at; so a VC fund has ten year term... meaning that all capital needs to be returned to the limited partners, which are the individuals or typically large endowment funds and so forth that will Twenty years ago, it really was an exit point for venture capitalists, but it is not... now. And, although it was not our case, I’ve seen many IPOs where the only way to actually get done is when the venture capitalist invests in the IPO... and to me that is really... you know, a strange concept.</td>
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<td>to build towards a trade… trade exit…</td>
<td>the opposite has occurred because there’s (sic) people leaving that area, the valuations have been quite low, the opportunities have been plentiful… and, now here’s the key point, it is something AV is good at because the people at AV just happen to come from that entrepreneurial background, we understand the special issues of starting and working with very young companies… Some venture capitalists, you know, they simple don’t have that background, don’t have that interest in, think it is too risky…</td>
<td>invest in a venture capital fund. If an investor is investing out of a fund that is later in its cycle, that can be challenging because there can be a misalignment of interests in the board.</td>
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Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

Moreover, the gap VC fund is essentially characterised as restrained in terms of the investment targets (i.e., can fund only in particular sub-spaces within a given sector and geographic region in the UK, no one-project companies, and a particular background funding condition: projects/companies rejected by other investors) and has, like most independent VC funds, a limited investment horizon (usually around ten years) but, unlike independent VC funds, faces some restrictions concerning the potential investment structure of deals (restrictions placed on co-investors) and preferred exit mode (only trade sales or mergers allowed, no management buy-outs or IPOs). Embedded, listed and even corporate VC funds, instead, do not face such restrictions so they can plan diversely in terms of who they decide to co-invest with, for how long and through which venture stages, and can even manipulate and time their decisions to convenience by “playing games” with the exit modality and timeliness.

Furthermore, embedded funds may play such games internally by moving successful projects forward from pre-seed to seed capital funding (crystallisation) and then all the way through venture capital and even private equity investment so that their deal flow very much resembles the R&D pipeline of an innovative company.
On another account, corporate and even State-backed VC funds are more likely to bear in mind strategic non-financial considerations that are not relevant for other types of fund investors such as independent listed or unlisted VCs. Consequently, it seems evident how IB, ITH&T impact IS (stand-alone funding or co-investing) and, therefore, preferences about the preferred stage to fund (very early, early or late) and exit mode. Those investors who fund projects on their own and face less pocket depth and ITH restrictions can create more and better options concerning the project stage in which to enter and the exit mode, while co-investing in combination with a limited ITH demands better timing decisions and may restrain the arrangement of available exit options.

These considerations have, obviously, impact on the interactions that sustain networking and knowledge acquisition/updating/enhancement. The complexity of investment decision making becomes more and more evident when this all is considered in the light of investors that may choose to either spread their risk by using traditional portfolio diversification or manage it through sectoral investment specialisation strategies.

**Trends of change**

*Finally, some wide encompassing trends of change such as the ones emerging from stratified medicine, mutations in some national healthcare systems and the greater involvement of corporate VC in the financing of early stage projects may have a powerful impact on funding mechanisms since they imply a re-organisation of the interactions and relations among the players (an example of co-evolutionary processes at work).*

At least two currently evolving trends come up as relevant concerning the funding of innovation in bio-pharma. The first one, stratified medicine, is a growing trend that will increasingly lead towards personalised medicine and is already creating imaginable changes in the business model. One of the central issues has to do with patents because stratified medicine developments are leading towards the creation of new therapies where tests and medicines are not standard for all patients, but will be specifically targeted according to an individual’s condition. Essentially, this means
that some existing therapies will have to be re-designed and new therapies will be synchronised with the test results.

Accordingly, IPRs and cost definitions will most likely be in the centre of the discussion about how to govern the changing model as it is widely recognised that the big question about stratified medicine regards patents, Since a lot of the target therapies are still protected by patents, “... some of the diagnostic tests are coming through all this challenge of who owns the patent and the whole thing of the ownership proof of the patents.” (I 5)

On the other hand, probable changes are also related to the size of the market for personalised therapies. How much will the shrinking number of target patients treated with a given therapy will affect the funding and in what way? That is, will the same sources and mechanisms of funding still be attracted to therapy development projects? If so, how will the conditions for such funding change?

Apparently, what is at stake is not only the definition of costs, IPRs and profit, all of which will obviously impact the financing activity, but the very way in which many of the companies and non-firm organisations involved in the changing model will relate to each other. So, it may imply major modifications in the governance pattern of the industry and the networking mechanisms that facilitate some innovative developments. In such a sense, some interviewees think that sectoral associations, for instance, have a big role to play in pulling diagnostics and pharmaceutical companies together so they work in closer coordination and under a trustful peer relationship that may help overcome the emerging challenges (Table 19).

Eventually, the sector model might evolve to the point that personalised test and therapy development will be more streamlined and will give greater room for smaller and more flexible companies to step up their relationship with big pharma.

A second important ongoing change spotted by bio-pharma actors regards the mounting scarcity of VC funding for early stage innovative projects in the sector, particularly in some national settings such as the UK, France and Denmark, and the consequently increasing importance of mixed public-private-charity co-investment.
Table 19 – Trends of change – excerpts from interviews

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<tr>
<th>INTERVIEWEES</th>
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<td>So you work with a lot of different investors over a period of 10, 12, 15 years and you get to see a lot of mechanics at operation… I would say complexity has changed, the number of people has also changed who are in the area, who are providing funding, investment, a lot more than they were.</td>
<td>... in the academic sector the feeling is that money is completely dried out. It's gone from the feeling that you had a 1 in 3 chance of getting a grant funded to a 1 in 15 chance of getting a grant funded, so the odds are very much against you.</td>
<td>Government funding programmes have slightly improved over time in France. Instead, there seems to be much less private money (VCs in general) available today, particularly after the 2008 crisis hit Europe.</td>
<td>I [stratified medicine] is a very influential approach because it means, in some cases, some therapies have to be complete re-designed and in others, new therapies, they have to be targeted for specific proteins so diagnostic tests have to be developed to prove the effectiveness of a drug according to the type of patient condition. This has a powerful impact on funding since it means that drug companies have to work closely with diagnostic companies. There is a lot of nervousness in VC with regard to diagnostic companies because the business model is not understood.</td>
<td>It [the Investment Time Horizon] is getting shorter, I think, because pharma is doing acquisition... So, when you start phase II, you can get acquired, half-way through phase II you can get acquired.</td>
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|  | I10 | I12 | I13 | I14 | I15 |
|  | There's been a move away from large headcount bio-tech companies to not much headcount but lots of experience. The industry is quite fragmented, so there is a contract organisation for every aspect of it. So VC funds do not want twenty expensive chemists doing stuff, while we can do this in controlled outsource packages. What we need are really experienced people to decide what the program is, what the project is, and who and how we outsource. | ... so the feeding, in other words, the IPO feed to AIM stopped. And the exit from the other side has continued, those coming in have continued to grow or they've fallen away, so it depends... while the climate has changed, it's become more difficult to IPO. | ... I think still this is an area where there can be made very good, very profitable investments, but historically it has just turned out that the public general investment market is not... does not really understand the life science sector very well. | The other major sort of positive move a realisation in the pharmaceutical companies that they are not good at high level innovation. So around the globe every pharmaceutical company is scaling back its research activity and using the funds that are being released by doing that to acquire assets at the biotech companies. So that is another very, very positive trend for us because we have a... there is a pharmaceutical industry that is hungry for our... the assets that we are building in our companies. | ... right now, the lack of access to capital so that is a good situation for investors because there is obviously... seldom will there be competing because all of them will want to invest, you know, it rather is that those who are interested will join forces and co-invest... going back five years there was always competition, so that is good for investors, bad for companies. |

<p>|  | I16 | I17 | I18 | I19 | I20 |
|  | What has changed, I think, is of course the risk profile both of the people and investors; so forth it has changed | I think there has been a huge dip in the access to funding from private investors primarily, live venture funds and | I think the industry as a whole has mutated from the brighter times of sort of 2005/2006, where you could raise money, | ... people say that there are less investors or there is less investment, It does not seem to me to be significantly | So, I would expect there to be now fewer spin out companies and a lot more partnering with companies that are |</p>
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<td>memories. So even</td>
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we will see continued trends in the orphan status.
I think the agency, the FDA specifically now has really moved to grant much faster regulatory times and reduced for drugs that are being [tested] on unmet medical needs, when there is nothing; I think they really improved in fast tracks status, I think that will bring the market to start looking at drugs where, you know, there is such an unmet medical need...

when they got burned on something a decade ago, does not mean they don’t want to take a crack at it now.

actually think that given the appalling productivity of big pharma, they are going to be progressively driven to do more and more deals with smaller companies.

Note: A longer table with further excerpts from the interviewees’ statements can be found on Appendix 1.

Source: Author’s own elaboration

In fact, according to several managers, the scene has been altered significantly by a number of factors: VC money is presently not so abundant, regional support funds (wherever they existed) have vanished in many cases due to austerity measures caused by the latest financial crisis, several generalist investors have simply stopped putting money in the sector, and even some specialised investors have broadened their portfolios by channelling funds towards close but essentially different sub-spaces such as healthcare IT and applications where pocket depth needs not be as large, ITH is shorter and risk is lower. Finally, the unpredictable IPO windows in the stock markets and the lesser palatability of such mechanisms for VC investors compounds a potentially more stressful landscape for bio-pharmaceutical firms looking for funding, especially those in very early and early stages and those with a single project pipeline.

These developments may further increase the importance of co-investment for the sector and also allow the strengthening of diverging strategies to cope with the characteristic features of innovation in the sector. In fact, the importance of collaborative solutions in the funding of bio-pharma innovation seems to increase. This may mean that charity very early and early stage funding, university pre-seed funding and any other similar mechanisms (e.g., business angel financing) may become more important to support start-ups in the bio-science space. It also may give
further power to funding syndicates, particularly among specialised investors and corporate VCs with strategic and financial goals.

“Pocket depth” and funding sources (and the investment base, ultimately) are not the only drivers behind funding modifications. Other factors such as investment horizon and the expansion of the whole industry knowledge base (e.g., further convergence between nano-technology and bio-pharma) are intertwined powerful influences as well.

Essentially, what these change trends (and possibly others not referred to here) show is the co-evolution of a number of factors and the connectedness of different dimensions inside this particular sector. One type of transformation, which concerns the “knowledge base” of the sector (i.e., the bio-pharmaceutical companies and non-firm players such as universities), will also have an impact on the “knowledge base” of the sector financiers. The other, which regards a modification of the economic and financial milieu, will in turn convey an effect on the mechanisms and decisions about the funding of innovation in the bio-pharma space.

4.3 Closing remarks

Summing up, our main findings regard the following chief issues: Firstly, a number of relevant themes emerge from the responses to interview questions: i) knowledge about the sector and networking building and updating; ii) interactions among players; iii) funding sources and mechanisms and their readiness to fund certain project/company stages; iv) five specific investors’ characteristics; v) some foreseeable trends of change.

Those main themes can be arranged into a hierarchical, self-supporting layout that reveals the sustaining underlying relationships among the relevant theme categories as codified, described, and exemplified through the narrative presented above.

Secondly, the essence of the testimonial statements collected through the interviews leads us to understand some of the underlying issues that ultimately give rise to a collection of statements that regard the roles and processes, and their protagonists, behind the decisions about the funding of innovative projects in the biopharmaceutical sector. From the evidence introduced, it can be asserted that:
i) The knowledge of investors about the sector (bio-pharma), that is their understanding of the science and technology behind innovative projects and processes that those projects go through, is key for both parties (funders and fundees) to reach agreements on funding amounts and conditions, and to “govern” the development of the projects;

ii) The creation and enhancement of a network of knowledge-relevant contacts is key in order for both parties to facilitate knowledge access and updating, track record verification, access to and structuring of funding, and enhancement of project team capabilities principally;

iii) Attitudes and investments (effort) concerning knowledge and networking access and enhancement mark clear differences between generalist and specialised investors. Such differences are additionally complicated by variations in investment base, time horizon and timing for investment, and preferences about investment structure, stage for investment, and exit mode;

iv) Funding-related interactions include players and roles other than fund seeker and potential investor and have a significant impact on the structure and time horizon of investment in innovation. These interactions are heavily conditioned by the availability of specific sources and mechanisms of funding and their readiness to finance certain innovative projects (stages) and by the surrounding conditions of the setting in which actors and interactions stand;

v) Emerging trends of change imply wide range adaptations in strategies (attitude and behaviour) and interactions of the different players that take into consideration the observed fellow agents’ mutations and emerging conditions and players in a given setting.
5. DISCUSSION

5.1 Introduction

In this chapter we put forward an explanation about the funding of innovative ventures in science-based sectors, such as bio-pharma, as considered under a systemic perspective. Consequently, it is here proposed that the funding of innovation takes place within a particular institutional financial layout conformed by the available sources and mechanisms that are ready to finance some or all the stages of the innovative projects. Venture owners and potential funders get in touch and establish/manage relations through networks of actors; yet, their interactions, networking included, are somehow conditioned by their characteristics and by the macro and sectoral milieu in which they interact.

The remaining sections of the chapter present these ideas in detail and are organised as follows. Section 2 explains the general sectoral perspective and specifies the most relevant traits, functioning and consequences of: a) innovative firms’ knowledge; b) investors’ knowledge; c) availability and readiness of funders; d) networking and interactions; and e) mutations and learning.

Section 3 discusses the main aspects of investors’ strategy and particularly develops: a) the connections between networking and the investors’ knowledge consolidation system (IKCS); b) the distinction between generalist and dedicated investors, and c) some specific issues that may raise further questions thereof.

Section 4, in turn, discusses some important implications that spring from the sectoral perspective introduced above and Section 5 goes into further detail to explain how this view enhances the systemic perspective and several concepts applied to the bio-pharmaceutical industry, and science-based sectors in general, as sustained by a few prior works.

5.2 A systemic perspective to explain innovation funding

The questions raised at the beginning of this research explicitly refer to who takes part in the allocation or refusal of external funding to innovative bio-pharma projects and how are those decisions made, on one side, and whether the initiative of only one
side (based on their own set of preferences) can successfully activate the financing mechanisms of innovation in science-based sectors such as bio-pharma, on the other. (see Chapter 2). A complete answer to these questions is what we intend to build up in this chapter.

Before attempting a reply to the questions above, it seems appropriate to recall once more that bio-pharma innovation is essentially characterised by fundamental uncertainty, very high risk, long term horizon, asset intangibility and specificity (i.e., science-based ideas, knowledge), huge importance of IPRs, high cost and, in what specifically regards the venture owner-potential funder relationship, knowledge gaps (information asymmetry).

With this in mind, the simplest response to the first question is that basically both project owners (firms or individuals) and potential investors do. Of course, other actors may play a part (e.g., policy-makers, contact facilitators, match-makers), but the star roles are reserved for these two players. Project owners take part because they are convinced about the quality and potentiality of their projects and have decided that they do not have or want to use (i.e., other uses are deemed more appropriate for) internal funding. Potential investors, on their side, participate because they need to find good investment opportunities to put their money in and make satisfactory profit (in the case of private investors) or attain desirable social goals (in the case of government agencies or charities).

The essential motives of both project owners and potential investors thus draw them together and this is an argument against the idea of only one party’s prevailing initiative which leads to the enforcement of certain preference-related criteria from one side (i.e., imbalancedness) as suggested by both selection and inducement approaches to financing innovation (see Chapter 2). That also implies that no party is a passive player as hinted in pecking order and passive search theories.

Moreover, unlike passive and active search theories suggest, “objective” selection criteria are not the core factors of project funding decisions. Actually, whilst the role of project owners in seeking financing is essentially based on the quality of the project and the team behind it, that of potential investors is conditioned by two related factors: interest and readiness. The interest of potential investors in funding a project is based on their knowledge about the project (including specific
activities/stages), about the team/firm behind it and the particular sector space or sub-space. The readiness of potential investors to fund a project is based on some peculiar investor’s characteristics and, once again, on their knowledge about the team/firm behind the project.

Additionally, potential investors’ interest and readiness are affected by some features of the narrow milieu (i.e., certain traits and trends in a sector space or sub-space) and the broad milieu (i.e., macro conditions). This dimension, which is essentially absent in the four main theories that make up the selection and the inducement approaches, where only regulation and some sort of social embeddedness are sort of nonchalantly mentioned to support the innovation funding mechanisms, may have massive impacts that will be discussed later.

Instead, we propose, project owners will always try to get the funding needed but they have to adapt their search behaviour not only to their preferences about funders, as the pecking order theory suggests, but also to the availability and readiness of funding sources and mechanisms in a given context (i.e., economy) since such sources are usually conditioned, as mentioned above, by knowledge, certain own characteristics, and the conditions of the narrow/broad milieu over the period of time in which the funding search and allocation process takes place. Moreover, both the knowledge accumulated about the project, about its owners, and about the space/sub-space, as well as some investors’ characteristics (readiness) may change over time thus modifying (increasing or decreasing) the interest of potential investors in financing a particular project; milieu factors play also their part and may, in turn, enhance the alterations in funding availability and readiness.

Thus, taking account of some basic conditions of the interaction between project owners and potential financiers and of some milieu factors and their changes over time helps eliminate the disembeddedness that characterises the existing explanations on the funding of innovation (see Chapter 2).

What this means is that certainly one party (either project owners or potential financiers) can attempt and may be successful at imposing certain overbearing criteria in a funding deal (selection or inducement approach bias), but that will not depend exclusively on the preferences or desires of one party alone. The existence of alternative projects and an array of funding sources/mechanisms, of knowledge
sources and learning mechanisms, the potential modifications of the characteristics of project owners and potential financiers, as well as some transformations in the narrow/broad milieu will always condition the behaviour of the main players.

Furthermore, the degree of knowledge that potential investors can gain about a particular space or sub-space is also a decisive factor in their designing a differential strategy to operate in a given sector: some prefer or are required to concentrate their funding activity in a space/sub-space and some others favour the diversification of their investment portfolio. This implies the existence of a direct link to the participation in networks in order to access knowledge and to structure deals.

Therefore, it can be said that the explanation proposed here differs from the existing explanations about the funding of innovation, particularly in a science-based sector such as bio-pharma, in a number of ways. First, our proposal is based on a continued and strong interaction between the two main players (project owners and potential financiers) which means that no party is essentially passive regarding the funding allocation process. Second, the interaction is fundamentally based on knowledge, organisational characteristics, and milieu traits that, along with preferences, may mutate over time and help shape the players’ interaction strategies. Third, knowledge and networks are intimately intertwined and play a significant role in the case of potential investors and the design of their sector investment strategies in particular which, in turn, has an impact on the players’ interactions. Fourth, the decision-making processes about innovation funding and their procedural or outcome adjustments over time can be described in a more complete, more explicit and more detailed manner.

These issues allow our explanation to overcome the lack of balance, bias, and disembeddedness that characterise the four main explanations about the financing of innovation presented earlier (see Chapter 2). Moreover, the explanation here proposed, unlike the ones reviewed earlier, allows us to build more coherent and complete answers to questions regarding, for instance, the convergence or divergence of interests among venture owners and potential funders, the adjustment of a player’s preferences, criteria and behaviour in the face of internal or external variation of circumstances, some differences regarding funding availability for one particular sector in different settings or changes over time, and differences in strategies and decisions among players in the same setting.
A first major issue in our explanatory proposal concerns the fact that both project owners and potential investors possess a system to manage the knowledge they have built up and to incorporate the new knowledge they need; we will call it a Knowledge Consolidation System (KCS). This construct is conceptually coherent with the starting ideas that organisations are systems of overlapping sets of knowledge, that learning takes place inside heterogeneous networks and among distinct actors and, furthermore, that such a phenomenon rises above the conventional organisational boundaries (Araujo, 1998).

In fact, venture owners in science-based sectors work around knowledge; they create it and use it as the basis of their projects, they acquire and update specific knowledge about how to innovate (in general, create new products or processes) (Liebeskind et al., 1996; Malerba, 2002 and 2003; McKelvey et al., 2004) but also about how to fund and manage their innovative projects. That is, innovative organisations harness their cutting-edge knowledge creation and application activities with some relevant knowledge about how to raise funds to support their innovative activities and how to manage all those activities, particularly in the presence of external players (e.g., managers or board members representing investors) because otherwise the economic fuel that drives the knowledge powerhouse may become depleted, especially if internal funds do not suffice.

This additional component of a firm’s knowledge originates in the networking with investors, particularly if specialists, and is tantamount to building up a track record and, thus, enhancing a firms’ knowledge about how to deal with potential funders and how to negotiate a deal to obtain external funding for their projects (e.g., applying for grants, selling the project to potential private and public financiers, contacting investors) (Hallen and Eisendhardt, 2012) or how to manage such projects by benefitting from funders’ coaching (Gorman and Sahlman, 1989; Bygrave and Timmons, 1992; Sapienza et al., 1996; Kaplan and Strömberg, 2004; Bertoni et al., 2011) and thanks to their own hands-on experience after the first project is successfully (or even un成功ly) run. This type of knowledge is as important as the scientific knowledge acquired and enhanced through basic and applied research and certainly adds up to the characteristic interdisciplinarity of a company’s knowledge stock.
In the case of start-up companies, under formation or recently established, most of this knowledge about fund-raising and venture management actually depends in a substantial measure on learning from the initial hands-on experience itself and from the coaching provided by the committed funders (i.e., incorporating or updating certain capabilities); also, such knowledge and learning process become the very track record that may, in the future, guarantee successful and easier access to funding for later stages or for a different project.

In a nutshell, the Knowledge Consolidation System (KCS) of venture owners involves both the knowledge needed to innovate and, also, the knowledge related to negotiating and securing funding for innovation projects and to actually managing those projects and the way such knowledge is incorporated into the organisation.

b. Investors have a complex Knowledge Consolidation System (IKCS)

An expansion of the sectoral base of knowledge à la Malerba, particularly regarding new basic or applied knowledge (basic science or technologies) in the core biopharmaceutical sector (i.e., the innovative organisations) (see Liebeskind et al., 1996; Malerba, 2003; McKelvey et al., 2004), essentially means a renewal of the information gap that separates potential investors and innovators in the industry. It is very difficult to measure the gap and it makes no sense to talk about the gap size in general because some players (firms and investors) will be closer to one another while others will be farther away. However, it is not difficult to recognise that the advent of new ideas, be it on the side of sectoral innovators that are moving on the frontier or on the side of financiers themselves (e.g., financial innovations applicable to the funding of innovation), will always generate a lag in extended understanding (i.e., diffusion of innovation, that is of knowledge) that those outside the project or firm, investors included, will have to try to fill up by whatsoever means they can resort to.

Moreover, knowledge is important for investors in other regards as well. Cassiman et al. (2010) identify four knowledge attributes of projects (basicness, novelty, strategic importance, codifiability)15 that are considered “… the fundamental project characteristics to explain the organizational form to be adopted” (p. 884) and which

15 The exact definitions provided by Cassiman et al. are the following: “(1) basicness—i.e., the extent to which a project refers to fundamental research ... and is aimed at developing new knowledge as opposed to exploiting previously held knowledge... ; (2) novelty—i.e., the extent to which a project’s knowledge is novel relative to the firm’s existing knowledge base... ; (3) strategic importance—i.e., the extent to which the firm will rely on the knowledge involved in the project to build its competitive advantage... ; and (4) codifiability—i.e., the degree to which knowledge can be codified as opposed to being tacit...” (p. 884)
have a huge impact on the valuation of project costs in terms of knowledge production, coordination and transaction. This implies that, regarding the funding of innovation, those potential investors that are more able to cope with the fundamental uncertainty entailed by the new knowledge (basicness and novelty) and who are more risk-oriented will probably be the first to make themselves available to fund such projects/companies either through a stand-alone operation or by co-investing along with other funders. Others will probably prefer to wait and “enter the game” only when a first bet has been made and a “positive signal” has been sent (Conti et al., 2013; Hoenen et al., 2014). What this means is essentially that, just like non-financial companies, investors in innovation can also be grouped into leaders and followers and such a division owes a lot to the knowledge that they share and to the way in which they build it and update it.

Initially, it does not matter if it is a private individual or an organisational investor or a government agency or what size they are in financial or staff terms, all of them need to have a Knowledge Consolidation System (KCS), that is to say a system to manage the knowledge they have built up and to incorporate the new knowledge they need, to operate successfully. Later on, we will discuss how differences in the funder’s traits can convey differences in their decisions and behaviour about their knowledge and their KCS.

A Knowledge Consolidation System (KCS) basically is, then, a mechanism, which entails certain procedures, to manage a “stock” of knowledge accumulated through past experience and learning and to capture and integrate a flow of fresh knowledge that is acquired from different sources through networking or by hiring knowledgeable staff. In the case of investors, this Knowledge Consolidation System serves the purpose of internally integrating the knowledge that underlies innovative organisations’ R&D (i.e., the knowledge underpinning innovation) in a sector (e.g., bio-pharma in this study), the knowledge about the funding of such projects (including what funders need to know in order to build up and manage funds and to choose projects where funds will be deployed) and, lastly, the knowledge that underpins the networking capability itself.

Thus, an Investors’ Knowledge Consolidation System (IKCS), just like that of venture owners, usually changes over time just as there are modifications that concern any or all the three main types of knowledge involved: financial technical
knowledge, knowledge about the core sector itself (i.e., about science and technology, products, firms, markets, and institutions), and the knowledge-based capability to network with sector experts and other investors with similar interests (Powell et al., 1996; Liebeskind et al., 1996; McKelvey et al., 2004) in order to bring fresh knowledge about the sector, innovation and its funding in, among other things.

These three issues work complementarily since the first two, particularly knowledge about the sector, usually make the investor’s knowledge gradually obsolete as scientific knowledge expands, whilst the third factor (networking with relevant players) helps update and enhance the very Investors’ Knowledge Consolidation System (IKCS) thus facilitating the integration of bits of the knowledge and experience of diverse individuals (e.g., scientists, managers, investors) and organisations (e.g., universities, research centres, companies, investment funds) into the domain of investors.

It is worthy clarifying that networking is a key component of the IKCS because its very existence is supported by the actual relationships and interactions established with other actors. In other words, no network exists if the “contacts” are only formal labels for potential exchanges that might take place at some point in time; conversely, the existing interactions and relationships substantiate the reality and effectiveness of the network.

An additional issue of interest concerning the IKCS regards what may be called a certain path-dependent trajectory in investment. If a particular investor has made an extensive effort to build up knowledge on a given sector space or sub-space, it may take considerable additional effort and costs to extend it even to a neighbouring or a far-away sector/sub-sector as it may imply substantial knowledge differences. That is why investors that “have made their money” in a given sector do not find it easy to move into a different, unknown industry; even if they are specialised, going from IT to bio-pharma, for instance, demands building up a substantially, if not entirely, different type of knowledge and, consequently, a diverse Investor’s Knowledge Consolidation System (IKCS), and even moving from one sub-space to another within the same sector (e.g., from antibodies to vaccines) may entail significant difficulties. It goes without discussion that an investor coming from a non science-based sector will find it even more difficult to build a completely new type of knowledge and a Knowledge Consolidation System from scratch, since learning from
previous investment successes and failures (and from co-investing) seems to be a determinant of investors’ (VCs in particular) effectiveness to manage their portfolios (Gupta and Sapienza, 1992).

c. Availability of funding, readiness to fund and some significant traits of investors

Theoretically, the array of available funding sources and mechanisms that can be used by innovators is very wide as it ranges from internal funds (in the case of companies operating with a profit) to bank or bond-based debt, to a long list of potential external equity financiers (Myers and Majluf, 1984; Norton, 1991; Holmes and Kent, 1991; Scherr et al., 1993; Chittenden et al., 1996; Berggren et al., 2000; Howorth, 2001; Cassar, 2004; Baeyens and Manigart 2005; Paul et al., 2007; Vanacker and Manigart, 2010). There is, however, some distance from reality as in many cases some of these sources/mechanisms are simply not present in a particular context (e.g., the lack of venture capital in some countries) or, in other cases, they are present but not ready to fund innovative firms in a given sector or, at least, some of their activities (Saltari and Travaglini, 2001; Hogan and Hutson, 2005; Hall and Lerner, 2010; Cassia and Minola, 2011; Nam, 2012).

Commercial banks or ordinary individual investors (e.g., family members and friends), for example, may be present and hold idle funds, but they do not usually possess the knowledge that enables them to undertake such an investment. In other cases, even specialised investors that enjoy the advantageous situation of having the funds and the knowledge (e.g., corporate and some VC trust and BA investors) may be discouraged by other contextual or funder-specific factors such as comparative disadvantages (e.g., unequal protection for different investors) or too short/long a time window to hold the investment. So, the existence of a given assortment of theoretically available sources and mechanisms to finance innovation is not enough to grant that such activities will be effectively funded; the institutional financial layout (IFL) that is relevant for the funding of innovative ventures in a given economy is made up of those potential investors that are ready to undertake true uncertainty, very high risk, long-term commitment, asset intangibility (at least until IPRs are secured), knowledge gaps, and other features characteristics of most science-based innovative ventures.
Moreover, the readiness to fund an innovative project or firm has also to do, in some cases, with a certain preference for the stage in which the venture is. Projects which are closer to the market (usually in late stage) may sometimes give owners access to sources of funding which are not available to early stage projects/firms. Actually, established companies with revenues and profits may not only use their own money, but may also be funded by banks, enter joint ventures with bigger companies (if any is interested) or issue bonds more easily than early stage, particularly pre-revenue, firms for instance\textsuperscript{16}.

The stage of an innovative project is thus particularly relevant for the decisions of potential investors. When the development horizon of a project is measured in decades rather than in years (as the case is in drug development), uncertainty and risk are much greater the earlier the stage and, obviously, they diminish as the project successfully goes through the different R&D phases. The nature of technical uncertainty may indeed mutate from unmeasurable to measurable (in the terms of Shackle, 1955 and 1961, and Knight, 1965) as the project is run through satisfactory clinical trials and a product is successfully created; however, other factors such as market uncertainty or general economic and political uncertainty may remain high. This all makes the calculation of risk, costs and returns for innovative projects tougher than usual (Freeman and Soete, 1997; Pisano, 2006).

Actually, the definition of failure and success may vary for different innovation stakeholders. In particular, venture owners and funders may have a different perception. Successful innovative projects are known to help enterprises become more competitive and entitle them to profits that can be appropriated to secure reinvestment and avoid skills and knowledge depreciation or obsolescence in front of competitors (O’Brien, 2003). However, failure does not involve only one specific project, unless a firm holds a single-project portfolio; for instance, competing innovative projects (parallel or competitive attempts to obtain similar results) inevitably imply some rate of failure for runner up projects/teams as these face potentially lower market shares and returns. Moreover, projects may fail at different stages: a technically viable project may not pass the screening stage where funding is decided upon, others may fail along the R&D phase even if massively funded, and

\textsuperscript{16} The use of external funds may have to do with insufficient internal funds or the availability of external funds whose cost is lower than that of internal liquidity (that can be profitably used in less risky investments). A third reason may be of strategic nature such as the externalisation of risk and costs through sharing (e.g., joint ventures on innovation), which implies the venture owner’s readiness to share at least some of the expected first-mover advantages according to the type of agreement.
others still may not make the grade during the use or commercialisation phase (in the case of drugs, some new products may not be approved by the regulator, for instance).

Furthermore, the probabilities of market success are difficult to estimate because of different reasons including: i- distance to market (time to develop a marketable product) and time for market development (from a few years to more than a decade in some cases); ii- impossibility to predict competitors’ future reactions (especially in oligopolistic sectors) or consumers’ trends; iii- difficulty to forecast future sales revenue and profit (especially in the case of previously inexistent products); iv- obsolescence that may kill a product or process even as it is launched (particularly if there are competing developments).

Additionally, failure risk in the case of highly innovative projects reasonably entails a difference concerning less innovative ventures even in late stages: it is difficult to reduce failure rates “by better management of innovation or project selection and control techniques, except for the adaptive and imitative type of project” (Freeman and Soete, 1997: p. 242).

These considerations can help explain why some investors prefer to fund late stage innovative projects since risk can be better understood and managed in such phase than they are at very early and early stages when true uncertainty is all around. Thus, investors’ stage preferences for investment (PSI) usually entail a trade off in terms of uncertainty/risk and cost/expected returns; a shorter investment time horizon means greater proximity to the market and earlier revenues, but also a comparatively higher investment ticket (cost to enter) and lower returns.

Finally, the management of innovative projects involves highly complex decision-making that implies learning “on the spot” in order to resolve true uncertainty, that is to say learning how to react to and manage unforeseen events and circumstances in the middle of those themselves. No wonder potential external funders react differently to such investment opportunities. This is even more so because the investors’ decisions concern matters (i.e., allocating funds and managing innovation) that are at the very core of their own and their fundees’ strategic activity.

Nonetheless, and with the only exception of grant funding and similar allowances, the readiness to fund specific projects or project stages can also be conditioned by
other features of the investors available in a particular context. The sources of the investment funds (the investment base, IB), no matter whether it is the State or private companies, individuals or other organisations, may establish specific criteria to throw money into certain ventures. State-funded VC organisations, for instance, may be directed to fund only ventures that comply with specific conditions (e.g., size, sector, geographic location and other policy-related issues), while the investment base, pocket depth and, to a lesser extent, VC team size may impinge on the length of the investment period and the timing of the entrance/exit within the frame of a given investment approach. Pocket depth and team size can also be decisive factors regarding the acquisition of the knowledge that may help understand investment options better as will be discussed later.

Likewise, the investment base can determine the time horizon of investment (ITH) by providing more or less funds to be invested in a given time window and by establishing a deadline when they expect to get the principal and returns back. The time window in which the funds are to be invested may or may not coincide with the time window that some innovative projects require, particularly if project development takes longer than the time horizon of the investors (as the case is often with bio-pharmaceutical innovative projects and some BA or VC investors) or if entrance is badly timed relative to the typical duration of an investment fund.

Actually, the timing of investments is also related to some investor’s expectations in terms of investment horizon and return. Essentially, the financial risk/return rule of a thumb is mediated by the time horizon of investment and timing in innovative projects, especially if they are science-based: earlier entrance and a longer investment horizon (i.e., true uncertainty and greater risk) usually mean higher expected/realised returns in bio-pharma (if the project is successfully run). Additionally, risk and return can also be better handled if better understanding and management of innovative projects are built up since the inception phase (even before any sort of organisation is set up) so that non-promising projects can be terminated or put on the right track in time to save resources. Consequently, the investors’ preferences for stage funding (very early/early/late) are also connected to their specific ideas on time horizon of investment and timing.

Concurrent with ITH&T, the investors’ preferences about the exit mode (PEM) may have an impact on the readiness to fund certain stages and on the investors’ strategy
in general. Once again, there is a rather wide array of possible exit modes for investors from management buy-ins to M&As and IPOs. An expected early exit may mean that certain modes (e.g., trade sale or M&As) are highly preferable over others that are more congruous with later stages (e.g., IPOs).

Another investor feature that influences a funder’s readiness to support a particular project stage is the *investment structure* (IS) of the deal. Investors may prefer either co-investing or investing on their own and may also alternatively prefer one-off operations or following their money through different stages. It is, of course, related to pocket depth, time horizon of investment and timing, and preferred exit mode in each case. Investing with others means establishing certain commitments as most innovation funders, at least in what regards bio-pharma projects, prefer to pool their resources with similar investors (e.g., State-sourced/private, corporate/independent, VCs/BAs) in order to harmonise time horizon of investment, preferred exit mode and preferred stage for investment as much as possible.

The nature of investors and their characteristics are then an important set of factors in understanding their strategic approach to the funding of innovation. In some contexts, for instance, public agencies or bodies, particularly those specifically created to support certain science-based sectors, may finance ventures that other funders do not accept (e.g., gap funding in pre-seed or even in seed stages) or serve as certifiers of the quality of such projects so additional funding can be thrown in by other investors (e.g., early co-investing with traditional or corporate VCs). The effectiveness of public funding, in particular, is conditioned by the visibility of the programmes/agencies (i.e., the information that fund-seeking organisations have or can get about them), the ease of access and use (display of a proactive/reactive strategy), the appropriateness for specific stages, the time horizon of involvement (short/long term), and other policy and non-policy related factors (Oakey, 2003).

d. Networking and interactions enhance the Investors’ knowledge and Knowledge Consolidation System (IKCS)

*Networks* are a key issue in building up the project owner’s and, particularly, the Investors’ Knowledge Consolidation System as they simultaneously help steer and embody knowledge (Powell et al., 1996; Spender, 1996a, 1996b; Araujo, 1998; Malerba, 2002; Pittaway et al., 2004). In fact, the latter aspect involves getting
funders and innovative organisations to come together around potential investment opportunities and helping multiple funders coordinate investments if their interest converges on the same opportunity. This last issue is also an important factor in the strategic management of risk; risk sharing through the pooling of investment resources, at least at the earliest stages of an innovative project, means a better coverage against the uncertainty of high level innovation (otherwise, conventional risk management techniques would apply) and boosts knowledge about effective portfolios’ management (Gupta and Sapienza, 1992).

As mentioned in Chapters 2 and 3, the bio-pharmaceutical sector is characterised by the participation of a wide range of organisational and individual actors that may play several different roles over time and across a number of (public and private) organisations and diverse situations. This means that actors’ roles involve different missions, activities and, therefore, various types of knowledge (e.g., project leaders, managers, entrepreneurs, advisors, funders, contact facilitators and match-makers) that are available through networks of different dimensions (regional, national, international) and that may potentially be of benefit to network participants.

The knowledge built up through professional training and experience conveyed by individual and organisational actors, many of which assume different roles over time, is the raw input that feeds and embodies network interactions and exchanges and contributes to enhance the knowledge and to strengthen the Knowledge Consolidation System of those actors ready to invest in networking efforts. Thus, network-based knowledge is the very blood of interactions and the input that feeds, particularly, the fundees and funders’ Knowledge Consolidation Systems; network participants can, consequently, also be characterised in terms of their knowledge sharing effort.

Strong (weak) networking, then, does not only mean potentially more (fewer) deals between investors and investees, but also more (less) knowledge transfer towards investors, which stands for a stronger (weaker) Knowledge Consolidation System and a more (less) effective management of uncertainty and risk on the investors’ side (Liebeskind et al., 1996). The construction of a solid Knowledge Consolidation System on the side of investors (IKCS) helps make up for the absence of collateral to back financial investment and for the knowledge gaps (others would say information asymmetries) derived from the innovators’ greater knowledge about the projects as it
facilitates monitoring the development of such projects over time. However, networking can be easily weakened if any of the links is struck by lack of credibility or trust, thus affecting funding/investment opportunities in a sub-space or even in the whole sector space (Casper and Soskice, 2004).

The close relationship between the Investors’ Knowledge Consolidation System (IKCS) and networks can also help explain why some theoretically available sources and mechanisms of funding are effectively not accessible to finance biopharmaceutical innovation (and innovation in other sectors, especially those based on science). Non specialised investors that are not familiar with bio-pharma, such as OTC funders (at least in the case of family, friends and foolhardy investors), commercial banks, potential ordinary bond/stock buyers, and even institutional investors, do not have an appropriate Knowledge Consolidation System (background knowledge, experience, networks) that enables them to manage the risk derived from fundamental uncertainty, the information gap, and the agency issues posed by screening projects and placing investments in such a sector.

Specialised investors such as venture capitalists (corporate and independent), business angels and some government investors are better geared to do so as long as they have a stronger Knowledge Consolidation System concerning investment in the innovative activities of the sector and of particular companies. A network-fed Knowledge Consolidation System might then help explain why stock markets, particularly science-oriented ones (e.g., NASDAQ, AIM, Neuer Markt), sometimes become insufficient to grant the IPO-based exit of early-stage investors in particular; a combination of few available high-risk profile investors with a weak Investor’s Knowledge Consolidation System (ICKS regarding a specific science-based sector) plus a few macro-environment negative signals (e.g., the 2008 financial crisis) or the pre-eminence of other “promising” sectors (e.g., the dot com boom in the early 2000s) and their eventual outcomes may drive away the interest of potential IPO investors, even if specialised in technological markets (Hopkins et al., 2013: p. 931).

Moreover, when some progressing trends of change such as the developments in stratified medicine or the changing role of some financing sources in bio-pharma (e.g., a growing participation of charities or the stagnant role of VCs in the UK (Ernst and Young, 2013)) are taken into account, it seems clear that such changes do have an impact on specific components of a sectoral system and induce
transformations that regard the players dealing with a SSI’s knowledge base (universities, research centres, firms) (in Malerba’s 2003 and 2004 terms); those core sector mutations, in turn, affect the Investor’s Knowledge Consolidation System (IKCS) by driving modifications in the network interactions that may help configure the decisions of potential external investors, private and public alike (Casper and Kettler, 2001).

In short, the episodes of learning that Araujo (1998) sees as springing from “… the committed participation of knowledgeable and reflexive agents in interaction and relationships forged within and across conventional organisational boundaries” (p. 327) underlie the importance of networking and support the general proposal that “actors, relationships and networks explain to a great extent individual firm and industry behaviour” (McKelvey et al., 2004), particularly when relationships and networks are focused on the access to valuable knowledge, which in the case of VCs and other external funders stands for knowledge meant to facilitate strategic investment decision-making.

In other words, it is necessary to specify that the knowledge and the Knowledge Consolidation System (KCS) of the actors (that of firms and, particularly, that of investors) is impacted by the transformations brought about by the co-evolution of several elements in the sectoral system (e.g., science, institutions, emerging actors, changing trends) and that is essential to account for the strategic decisions made by the players in the financing of innovation in a given context, particularly in science-based sectors.

Actually, this does not dismiss the fact that funding decisions are also shaped by distinctive features or preferences tied to specific contexts: see, for instance, the role of the geographical co-location of at least one investor and the investee concerning contact, exchanges, and monitoring in the case of the UK and some US regions (Gupta and Sapienza, 1992; Kenney, 1998; Powell et al., 200217; Rosiello and Parris, 2009) or the role of stage valuation since “local VC support [in the US] is directed to
much earlier stage companies, while external support flows to companies that have to ‘show’ more in order to attract financing” (Powell et al., 2002: p. 303).

Furthermore, the importance of the Investors’ Knowledge Consolidation System (IKCS) being rooted in strong networking and context-specific features for successful interaction and engagement with innovative firms is indirectly confirmed by comparative studies. Some substantial differences between German and British bio-pharma, for instance, seem to be attributable to the existence of certain non-market institutions in the former case and their absence in the latter. Some studies conclude, for example, that a major problem with funding this sector in the UK regards a crisis of confidence in the capabilities of the actors of the investing sector (VC funds and investment banking, specifically) to “govern projects adequately.” So even if the British institutional financial layout includes the most successful by far technology-oriented stock exchange in Europe (AIM), a central component for the flourishing of a liberal market-oriented model, some authors conclude that UK institutions “have not gelled into a sectoral support system capable of systematically supporting entrepreneurial biotechnology firms” despite the fact that the British biopharma model has been designed so that it seeks to closely resemble the successful US paradigm (Casper and Soskice, 2004; Casper and Kettler, 2001).

Now, the interactions leading to innovation funding within and outside the networks of players are, thus, contained in the framework established by the institutional financial layout mentioned above and the basic elements of the Investor’s Knowledge Consolidation System (IKCS). Specialised investors (e.g., VCs of all types) differ from non-specialised ones (e.g., commercial banks or ordinary individual investors) in terms of their Knowledge Consolidation System (knowledge content included) as defined above. However, not all specialised investors are ready to support the projects of innovative companies in a given science-based sector (such as bio-pharma) because they may decide to focus their interest in other less uncertain, less risky, more short-term oriented sectors as is at least partially true for generalist investors that choose a risk spreading investment strategy. On the other side, non-specialised investors devoid of the appropriate knowledge may take their chances even if on the basis of different reasons, such as family members and friends who decide to support an innovator because they have empathy with or blind faith in the person/project.
In some other cases, the inadequate networking may mean a plain lack of contact among project owners and effectively available funding sources or, even if information is available and contact is feasible, trust or interest may be lacking to enter into an agreement. This may happen, for instance, when innovative firms do not want to disclose information about themselves and their projects or when they simply do not want to involve external financiers in their strategic decision-making and prefer to resort to some form of bootstrap finance. So, interactions among players in a sector such as bio-pharma may be influenced by as different factors as their knowledge, the Knowledge Consolidation System of Investors (IKCS), the availability of funding sources/mechanisms, networking, and trust.

Trust, in particular, deserves special consideration when discussing network interactions concerned with complex ventures, such as those involving innovation in bio-pharma, due to the features of the projects (information and knowledge comprised), the actors and their interactions as explained above. Trust may start at the level of individuals, but it extends to “people and their systems” and it eventually allows the networked players to act “…as if the uncertainty that we face is reduced, although it does not reduce that actual uncertainty.” (Tomkins, 2001: p 265). Thus, we posit, knowledge and trust go hand in hand and are essential for investors and fundees in science-based sectors to build and update their Knowledge Consolidation Systems to the extent that it becomes a proper institution that emerges from the interactions in which the different players get engaged.18

Finally, the interactions among the different actors also undergo the effect of the sectoral and macro environment factors. The use of the financial markets, for instance, does not depend exclusively on the costs and risks of undertaking an IPO (sometimes deemed excessive) but, also, on the general mood and perception of the market investors (potential stock buyers, specialised or not) about the worthiness of investing in a given sector not only on the basis of the promises embodied by such a sector, but also in the light of past experience in a sort of path dependency that influences the behaviour of some investors (remember the effect of the dot com case at the beginning of the last decade, for instance).

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18 For a detailed discussion on the concept and role of trust and the way it is modified over time in relation to the sharing of information and the mastering of events in the world of entrepreneurial organisations in particular, see Tomkins (2001) and Welter and Kautonen (2005).
e. Changes are a constant driver of learning

Still another powerful factor is embodied by the evolutionary trends, the changes that arise here and there concerning a sectoral system. Stratified medicine and the path increasingly leading towards personalised treatments, for instance, imply several changes in the approach to the development of therapies that start with the tests designed to screen the conditions that affect a person’s health. Those modifications also affect the funding of the R&D activities, particularly in a sector in which the public health system in many countries is a cornerstone as it has a powerful role concerning the demand for new medicines.

But change trends also happen amid the financiers themselves. Such transformations may be short or long-termed and may alter to different degrees the relations and interactions among the investors themselves and those with the potential investees. Let us take, for instance, the case of the investing trends that helped create the bubble in the dot com sector in the final years of the last century and the first ones of the present; private investment funds can be drained from other sectors and pour into the promising bet spotted, thus generating overinvestment (due to the high expectations) in one sector and underinvestment (less interest) in those sectors skipped by the funders in favour of the highly promising opportunity. At that point, public investment may have to step in to try to compensate for the needed financing that has left; this should be seen as a move to complement, not compete with, the private investors that for any given reasons have remained trusty and interested in the sectors overlooked. This may also happen within a single sector when, as shown in the findings above, investors desert early stage projects/companies and move towards late stage thus creating the need for official funds to move in without creating the so-called crowding out effect. This sort of trends, temporary or long-lasting, may help explain the reactive character of at least some public venture capital in supporting innovation (Oakey, 2003).

If the changing role of some financing sources in bio-pharma (e.g., growing participation in funding by charities and at least stagnant in the case of UK VC funds), which is seemingly a worldwide trend (Ernst and Young, 2013), is added to the factors explained above, it seems clear that changes do not only have an impact on one specific component of the sectoral system and that such transformations affect the Investor’s knowledge and their Knowledge Consolidation System (IKCS)
as well and drive modifications in the networks and interactions that help configure the decisions of potential external investors, private and public alike (Casper and Kettler, 2001).

Thus, we essentially agree with McKelvey et al.’s (2004) statement that players (with all their particular characteristics!) and the relationships and networks they enter may account for the strategic behaviour of individual firms and any industry as a whole. Nevertheless, we add, the knowledge and the Knowledge Consolidation System (KCS) of the actors (which may be public and private, venture owners, funders, and even policy-makers and other support role-players), which is wider than the “knowledge base” proposed by Norton and Tenenbaum (1993) and Malerba (2002), and the changes and transformations brought about by the co-evolution of the system elements also help account for the strategic decisions made by the players in the case of innovation financing.

Some other times, certain decisions are shaped by distinctive features or preferences apparently tied to specific national contexts; for instance, European VCs seemingly restrain the reach of their investment geographically, while such case is less evident in US VC (Ernst and Young, 2013: p. 38), where there is evidence that “local VC support is directed to much earlier stage companies, while external support flows to companies that have to ‘show’ more in order to attract financing” (Powell et al., 2002: p. 303). This may partially explain the importance of proximity (geographical co-location of at least one investor and the investee) in relation with contact, exchanges, and monitoring in the case of UK and some regions in US bio-pharma19 (Kenney, 1998; Powell et al., 2002; Rosiello and Parris, 2009).

Also, track records (i.e., demonstrable successful experience) are not only important for companies to attract potential external financiers, but also for investment organisations such as VC funds to attract investors (be them individuals, corporations or other organisations) and that is not an easy task given the characteristics of innovative projects in bio-pharma and the difficulty for VCs to identify potentially

19 The conclusions of the study indicate, in fact, that in US biopharma, “[T]he locally-funded firms were smaller, younger, more science focused (measured by the percentage of PhDs and MDs on their payroll and their number of R&D collaborations) and likely to have more exclusive relations with only one or two VCs. The biotechs that garnered external support were larger in size, older, and had advanced to a stage where their work had moved further down the product life cycle (measured by their ties to other organizations to assist in commercializing products).” Concerning VC funders, the conclusions highlight another effect of location over time since “… there is evidence that, as the VCs grow older and larger, they invest more in both younger and more distant biotech companies. These gains from experience are tempered somewhat by location.” (Powell et al., 2002: p. 303).
successful investment opportunities (Powell et al., 2002). Evidently, other specialised
investors such as corporate VCs and business angels (BAs) have an advantage in this
regard. This emphasises even more the importance of continuously enhancing the
IKCS through vigorous and continued networking. As mentioned earlier, if IKCS is
supported by strong networking, the outcome will be successful interaction and
engagement with innovative firms.

In a nutshell, we propose that the funding of innovation (in sectors such as bio-
pharma) may be understood in terms of the strategic decisions that are made by
actors on both sides (project owners and potential investors) who exhibit particular
characteristics and who interact, within and outside networks, to different extents and
for a variety of purposes. Such interactions, including the articulation into the
networks themselves, are related with and impacted in more than one way by the
knowledge and the Knowledge Consolidation System (KCS) of all the actors
(potential funders included), the institutional financial layout (characterised by
different states of readiness to support innovation), some factors of the sectoral and
macro environment, and the co-evolution trends that take place in the macro and the
sectoral environment that may have several interrelated dimensions (local, regional,
national, international).

It is not simple to establish the causality effects of these factors and forces because in
many cases they affect one another and the drivers behind the transformations may
be varied, related to more than one element in the sectoral system, and exert
influence on more than one sectoral dimension simultaneously, as the case is in most
complex socio-economic-political systems. This is in line with the views that
consider the co-evolution of different elements and factors within a sector space as a
key force to explain the transformation of sectoral systems (Malerba, 2002 and 2003;
Rosiello and Parris, 2009; Casper and Kettler, 2001).

5.3 Investors in innovation and their strategy

The evidence provided by the bio-pharma firm managers and investment
practitioners interviewed confirms that venture capital funders of SMEs and start-ups
are usually private or government-backed VCs, business angels and, sometimes,
charities and they belong into one of two categories: generalist and specialised.
Generalist investors are broadly characterised as reactive funders and portfolio-based risk diversifiers; this is consistent with the prevalence of what some authors call the scouting/selection function (i.e., hand picking the best projects among those forwarded by different companies to build up a portfolio of innovative and non-innovative companies from different sectors).

Specialised investors, on the contrary, are largely perceived as rather proactive and focused funders with a better knowledge of the bio-pharma space or some of its subspaces, which means that the coaching function may have the upper hand in this case (i.e., helping develop the potential of firms/projects by using their extended knowledge about the sector) (Luukkonen and Maunula, 2007). Moreover, there is no agreement about further standards to classify investors into specialised and generalists; the discussion about fund concentration in an industry is unresolved as shown, for instance, by Norton and Tenenbaum (1993) using the under/over 50% of capital invested in seed financing (with lower diversification) as a pragmatic classification criteria, whilst Rosiello and Parris (2009) consider that specialist investors should concentrate at least 60% of their total portfolio investment in one sector firms (e.g., bio-pharma, IT, communications, media).

Accordingly, generalist VC investors in bio-pharma seem to better fit the literature that sees potential funders in general, and VCs in particular, as actors that essentially assess projects “objectively”, throw money into those deemed to be “the best”, may complementarily coach the investees, and crop returns, finally. Specialised investors, on their side, exhibit characteristics that do not seem to completely fit in the theoretical model described. Thus, our findings regarding financing innovation in bio-pharma seem to initially confirm the sense and substance of the proposals that see a double strategic approach to VCs investing in science-based sectors: generalists and specialised investors (Bygrave, 1987, 1988; Norton and Tenenbaum, 1993).

But, is it just a matter of fitting descriptions and labels or does a deeper issue run beneath the discussion about the two functions or categories of VC funding? While there seems to be positive evidence about the fact that innovative performance proxied by application for patents by a firm (although not the number of patents granted) is a factor for VCs to select a firm for investment (Mina and Lahr, 2013; Conti et al., 2013; Hoenen et al., 2014), the coaching function is still present as it is consistently performed by VCs out there. Is it then an abnormality or a caprice of the
innovation funding sphere? Is it wholly justifiable in terms of enhancing the strategic and operational conduct of firms even if no positive effect on innovation performance (patents obtained) is identified?

If all VCs perform both functions, but make their investment decisions based on their selection capabilities, then the coaching function might be seen as merely complementary and could even be discussed in terms of its need, cost and effectiveness. For instance, if all VC investors select the “best” projects, no error selection should take place and, consequently, most or all the projects chosen should be successful. But then, why are VCs ready to accept a high rate of failure? Why should a Gap VC, such as the one set up in the UK to fund innovative start-ups for a specific region and sector, be necessary? Also, why some projects that are initially rejected (meaning that they are not among the best), then become successful either by being funded and supported by a Gap VC or by a different funder that picks up the signal of the “certification” issued by the Gap VC or any other venture funder?

The prevalence of the VC selection function can help explain the preference for late-stage project funding among generalist investors. But then, what about early stage projects and firms or start-up organisations that have not applied for and much less obtained any patent yet? Should they be excluded by the selective investors or is there something else that may catch the eye so they are funded? Or is it maybe that, as Mina and Lahr (2013) propose, firms may disclose patenting activities only to what they consider serious prospective VC investors? To try an answer to these and other questions related, we posit that instead of talking about the two functions already described, one should really talk about two different types of investors defined in accordance with the distinctive strategies they design and implement.

We may depart from the general statement that while generalist investors predominantly select the companies/projects that they are ready to fund from a wide range of preferentially late-stage varied-industry proposals usually submitted to their consideration, specialised (better yet, dedicated) investors essentially seek and help shape very early and early-stage one-industry proposals. What is behind this assertion?

When thinking of the information gaps (asymmetries) regarding the knowledge on innovative projects that characterise the relation between project owners and
potential funders, two types of actions seem plausible to fill up the gap: either the project owners come forward and fully explain their projects (in the case they effectively need funding to develop it) or the potential funders try and find as much information as possible about those projects that may constitute fine investment opportunities, even if their owners do not submit them to be assessed and screened.

In the first case, there is a good chance that the existing literature on project internal selection within the firm and subsequent submittal for the consideration of external funders (Eckhardt et al., 2006; Hallen and Eisenhardt, 2012) –when necessary or preferred, according to the circumstances (Myers and Majluf, 1984; Saltari and Travaglini, 2001; Hogan and Hutson, 2005; Cassia and Minola, 2011; Nam, 2012)–, and the successive selection by potential external funders (VCs or BAs mainly) according to specific criteria (Knockaert, Clarisse, and Wright, 2010; Bertoni et al., 2011) has built a rather complete and detailed picture. The second case, instead, seems to have been only partially explained by the literature that supports the coaching function.

In order to explain how the two distinctive strategies imply the co-existence of two types of investors, we need to start by re-defining two conceptual dimensions of search behaviour (Katila and Ahuja, 2002) in the framework of innovation financing. **Scope** can be defined as the degree of new knowledge about a number of sectors that are considered for potential investment opportunities; **depth** can be defined as the degree to which the search effort revisits existing knowledge and determines the need for further knowledge about a particular sector where likely investment opportunities are spotted.

In order to make investment decisions, investors may decide that they will engage into a search characterised by either a wider scope or a deeper reach. A **wider scope** may mean a search about several sectors and firm/project stages, which may turn very useful if the investor wants to set up a diversified portfolio of projects/companies. A **deeper reach** may, instead, mean an intensive search about one particular sector and, possibly, one particular stage, which may be useful for an investor that wants to specialise in a space/sub-space. Now, we proceed to examine the role of knowledge and networking in the definition of the investment strategy.
a. Investment strategy: Network-based access to knowledge is key for the IKCS

How is the investors’ knowledge consolidation system (IKCS) built? Mostly, it is the result of creating appropriate “learning mechanisms” to build up knowledge through hands-on experience and networking with varied and experienced figures in the space of interest. Knowledge about a space (e.g., bio-pharma) or a sub-space (e.g., immunology) and, to a certain extent, the IKCS are a function of the networking effort (strength and continuity of network enhancing) undertaken by an investor. Because search is costly, a sustained networking effort leading to enhancing the knowledge of a sub-space/space (learning) is only compatible with specialisation. In other words, only investors that want to place a substantial share of their funds in a given sector will undertake seriously the costly effort of linking to a multitude of individual and organisational players that will bring expert insight about the science/technology (and related products and markets) and the trends in the sector of interest, other than new plausible mechanisms to fund science-based ventures.

Following Araujo (1998), knowing (i.e., learning) can be here defined as acquiring knowledge from and about interactions within the networks of relevant actors and incorporating the relevant knowledge present in such networks into one’s own organisation, mainly VCs in this case. Network-based learning involves different types of network players (individuals and organisations) and various types of formal and informal relationships (with or without contracts) so that the organisational boundary often becomes blurred. In this particular regard, it is good enough to think of a VC fund where investment managers keep in touch with former colleagues, known non-executive managers or even scientist friends in order to share information about or more formally ask for/offer advice on investment opportunities (ideas/projects/companies) outside any legal contract to do so; another illustrative case is the temporary participation of VCs and BAs in the boards and management bodies of investees for monitoring and coaching purposes.

Now, knowledge attainment in such an environment is influenced by three dimensions present in the networking experience: Intensity, Diversity, and Acquisition. In fact, we can adapt and redefine Yang et al.’s (2009) constructs by incorporating into their three dimensions of experience accumulation the specificities of innovation financing strategies.
The intensity of networking ("the number of instances of repetition in the learning-by-doing process") allows the funder to accumulate knowledge by evaluating the actions and outcomes, and by drawing generalisations concerning the causal relations between such actions and outcomes. Concerning innovation financing, intensity may refer both to the linking and interactions within certain networks, and to the volume of deal flow generated through networking.

Diversity ("the extent to which experience is accumulated through the solution of a diverse range of problems associated with subjects of interest") also applies to both, the networking effort and the problems that concern each particular investment opportunity (project/company) given the huge variation involved by innovation.

Finally, the acquisition effect ("the experience [and knowledge] borrowed from others") is verified through the successful networking effort (linking with all types of experts active in the sector sub-spaces that are incorporated through the network). In the case of CVC, for instance, there is in fact a proper experience acquisition through the parent company’s participation in the ownership of the innovative company (Yang et al., 2009). By contrast, such experience and knowledge will be “external” to investors that do not participate in networks (see Gupta and Sapienza, 1992, and De Clercq and Dimov, 2008, about the joint role of internal and external knowledge represented by prior hands-on experience and participation in syndicate partnerships, for example).

Now, the Investor’s knowledge and their Knowledge Consolidation System (IKCS) change over time, just like those of innovative firms in any given sector (Malerba, 2002), because new information has to be incorporated as innovations arise. Specifically, network-based learning modifies the Investors’ Knowledge Consolidation System (IKCS) and their knowledge when new funding sources/mechanisms are developed (financial technical knowledge) or when the knowledge of the core organisations (e.g., universities, firms, research centres, regulators) (knowledge about sector-related science/technology, including markets, products, and institutions) changes, and when networks evolve in terms of structure and contents (players, relations, knowledge available) (network-related knowledge and capabilities).
In short, one could affirm that the higher the networking effort an investor realises and the more experience in networking is accumulated, the more and better knowledge such player will build up as an outcome of greater intensity, diversity and acquisition effect. This mechanism helps explain the differences between generalist and dedicated (sector-specialised) investors and their distinctive strategic approaches.

b. Investment strategy: The distinction between generalist and dedicated investors

By introducing the previously re-defined concepts of scope and depth in the framework of investment decisions, it becomes easier to understand when and why funders decide to engage into an active search of (or even the passive reception of unsolicited) investment opportunities characterised by a preferably wider scope (several sectors and firm/project stages) or a deeper reach (an intensive search about one particular sector or sub-sector and, probably, one particular stage to begin with).

Generalist investors favour a scope approach based on the consideration of investment opportunities from a wider variety of sectors and give preference to late-stage opportunities that involve less fundamental uncertainty even if the investment ticket is higher (to compensate for the greater information available and the lesser risk), and because exit from these sort of opportunities may mean higher secured profits as well since IPRs are already formally established. Generalist investors are not interested in huge networking efforts because they do not need/cannot afford a very deep knowledge of the science/technology behind the most innovative projects in a wide range of sectors (see Hopkins et al., 2013: p. 930); also, their strategy is based on the application of “objective” criteria to select rather “mature” (late stage) investment opportunities that will make part of a highly diversified portfolio across different sectors in order to spread risk. This also helps explain their reactive nature as investors since it will be highly difficult and costly to gather knowledge about a big number of sectors to make decisions about ventures; they simply prefer project owners to submit their proposals for consideration and screening, although an occasionally proactive search for a project is not rejected if previous links exist (see Hallen and Eisenhardt, 2012).

Of course, there is some degree of learning-by-doing present in this strategy that helps consolidate the selection function (similar to what Yang et al., 2009 find for
CVCs), but the intensity and diversity of learning by investing in a highly diversified portfolio of late-stage opportunities offered by a wide variety of companies and sectors (scope approach) is not comparable to the characteristics of the learning process embodied by the alternative depth approach.

An issue of particular interest here regards the preferred stage for investment. In fact, evidence from our interviews diverges from Yang et al. (2009) who affirm that CVC programs are bound to invest in different stage companies so “... a CVC program may obtain the diversity of experience that can help it to formulate a complete picture of the portfolio company’s life cycle, leading to better judgments on investment decisions” (p. 265). This, however, might be valid only for CVCs and not for independent VCs as will be discussed later.

On the contrary, dedicated investors prefer a depth approach where consideration of investment opportunities is restricted to fewer sectors and concentrates in very early and early stage opportunities that entail more fundamental uncertainty and higher risk. This is because the investors’ deeper understanding of the knowledge behind the science/technology of the projects/companies and the requirements to assess and manage such projects more appropriately, based on their knowledge and experience and the additional network-based knowledge (De Clercq and Dimov, 2008), allow them to build a better de-risking “methodology”. Such an approach has to do with helping the project owners shape the idea/project right since the beginning. This is entirely consistent with and explanatory of the evidence gathered by Norton and Tenenbaum (1993) regarding the fact that “[T]he high seed group [investing 50% of capital or more in this stage] is diversified across fewer industries and has investments in a smaller number of companies than the low seed group.” (pp 438-439)

This is because the intensity, diversity, and knowledge acquisition effect that characterise the networking effort undertaken by dedicated investors strengthen the knowledge and the Knowledge Consolidation System of such financiers (IKCS) regarding investment projects in specific spaces and sub-spaces such as bio-pharma and immunology (De Clercq and Dimov, 2008), thus enhancing the depth reach of the search for investment opportunities. As a matter of fact, the superior gearing for performance of firms that learn deeply about a specific domain is supported by a greater comprehensive understanding of new information, a more abstract mapping
of the firm’s activity domain and a higher level articulation and codification of its knowledge base, and a greater ability to incorporate additional knowledge into its operations (De Clercq and Dimov, 2008: p. 587).

Thus, selecting/shaping and learning are not just two different types of investors’ behaviour. They embody two approaches that beget entirely different types of investors that can operate in the same sectors, but target different types of projects and companies (Figure 15).

**Figure 15 – Different knowledge acquisition strategies and types of investors**

Note: The continuous and discontinuous arrows mark two alternative paths for investors according to the way in which they build up and update their Knowledge Consolidation System (weakly or strongly linked to networking).

Source: Author’s own elaboration

This can help explain why some bio-pharma independent VC financiers pick up their fundees among those firm investment proposals submitted to their attention by using specific “objective” criteria such as the application for patents (selection function) and prefer those that are closer to the market (late stage); they will still be able to
offer some coaching regarding a better focus in the entrepreneurial process that will, for instance, avoid “the dispersion of inventive efforts... and [to] focus on the opportunities with the highest commercial potential” (Mina and Lahr, 2013).

Other investors, instead, put learning (building up knowledge) at the core of their strategy as a way to cope better with the salient features of bio-pharma innovation (fundamental uncertainty, extremely high risk, continuously growing information gaps (asymmetry\textsuperscript{20}), high intangibility and specificity of assets, longer time horizons, strong role of innovators) by helping shape the project/company itself. The learning function (which is different from the coaching function) is costly, so investors that have accumulated certain experience and information regarding companies and business areas, and are able to attain more through networking, will focus their efforts in those where they already have cost advantages over others. This is also a main reason behind the path dependency of their investments\textsuperscript{21}.

Moreover, since innovative projects/programmes tend to be more affected by fundamental uncertainty regarding its potential outcomes at the very beginning of the research activity and such uncertainty diminishes as the project progresses and new information and knowledge are consolidated, an alternative way to de-risk the investment is to get involved earlier so that greater knowledge that may facilitate better management is obtained and used. Consequently, it is not surprising that the traditional portfolio building techniques (used by generalist investors) need being re-considered since “... standard risk-adjustment methods will not work well... the variance of a portfolio constructed from such assets is unbounded so the usual diversification analysis does not apply”, at least to certain types of innovation (Hall, 2010: p. 4).

Our explanatory proposal supports Norton and Tenenbaum’s (1993) idea that investors, particularly VCs, that fund projects/firms where very high risk is involved, as the case is with innovative, early stage financing deals in science-based sectors, “... should be more specialized, should have a more narrow industry focus, and may

\textsuperscript{20} The two terms are not strictly equivalent as concepts, but they are inevitably related as opportunism remains a possibility in external funding relationships, which is why track records, networking and trust-building mechanisms are so important even when potential funders’ “objective” selection criteria are satisfied. That is one of the basic reasons for external funding to be more costly than internal resources under the Pecking Order Theory, for instance. Knowledge gaps are greater in earlier stages and tend to diminish over time (along with opportunism) if learning is a central component of the funder’s strategy and commitment.

\textsuperscript{21} Interestingly, this seems a rather appropriate way to express the evolutionary concept of commitment, as stated by Diamond (1997); in fact, evolutionary biologists conceive evolutionary changes as incremental and coming about “through the accumulation of small changes in an evolutionary design adapted to a different but related lifestyle.” (pp 70-71); this seems a concept altogether appropriate to understand the approach of dedicated investors.
be less diversified than those who finance later stage deals.” (p. 435). All this notwithstanding, fundamental uncertainty is still a driving force behind the decisions made by investors that tackle early stage ventures, as Yang et al. (2009) point out, and therefore intuition has still a complementary role under such conditions; both, project owners and investors have to be permanently on alert to “read the situation” as best as they can, so their decisions are eventually as good as they can be. In this sense, the investee-coaching function carried out by dedicated investors is broader than that developed by generalist investors (see Table 20).

Table 20 – A summary of the main differences between investors

<table>
<thead>
<tr>
<th>Strategic approach</th>
<th>Dedicated</th>
<th>Generalist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roles: Funding</strong></td>
<td>Learning and Shaping</td>
<td>Selecting</td>
</tr>
<tr>
<td><strong>Roles: Monitoring</strong></td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td><strong>Roles: Coaching</strong></td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td><strong>Strategic approach differential issues</strong></td>
<td>Very early / early to late stage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Idea-centric (pre-IPRs)</td>
<td>Late stage</td>
</tr>
<tr>
<td></td>
<td>Mostly proactive “Learning” criteria</td>
<td>Mostly reactive “Objective” selection criteria</td>
</tr>
<tr>
<td></td>
<td>Depth approach</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher networking (and network-based knowledge)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher learning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher shaping and coaching</td>
<td></td>
</tr>
<tr>
<td><strong>Lead co-investor</strong></td>
<td>IKCS (see Figure 16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Network-Based Knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Financial Technical Knowledge</td>
<td></td>
</tr>
<tr>
<td><strong>Longer term commitment (ITH)</strong></td>
<td>Pre-seed / Seed (Crystallisation)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Follow on Knowledge of most/all stages</td>
<td></td>
</tr>
<tr>
<td><strong>Combination of science / people / financial criteria</strong></td>
<td>More “financial criteria”-led</td>
<td></td>
</tr>
<tr>
<td><strong>Last to exit when return flows and time decrease (deeper commitment)</strong></td>
<td>First to exit when return flows and time decrease (shallower commitment)</td>
<td></td>
</tr>
<tr>
<td><strong>Easier shift into new sub-space or space (See IKCS)</strong></td>
<td>Harder shift into new sub-space or space (See IKCS)</td>
<td></td>
</tr>
<tr>
<td><strong>Other key fund characteristics</strong></td>
<td>Investment base (IB) (impact on pocket depth and team size)</td>
<td></td>
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<tr>
<td></td>
<td>Investment time horizon and timing (ITH&amp;T)</td>
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<tr>
<td></td>
<td>Investment structure (IS)</td>
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<td></td>
<td>Preferred stage for investment (PSI)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preferred exit mode (PEM)</td>
<td></td>
</tr>
</tbody>
</table>

Note: *Higher* and *Lower* are used to establish comparative degrees between the two types of investors.

Source: Author’s own elaboration
We think that the Investor’s knowledge and their Knowledge Consolidation System (IKCS) concept can be used to help characterise the fundamental differences among investors and the possibilities of transformation over time. In fact, technical knowledge about the financial world tells specialised (high technical knowledge) from non-specialised investors (low technical knowledge). However, network-based knowledge that feeds the knowledge about the core organisations (learning about the science/technology underlying sector-related projects) is needed to tell dedicated (high level of network-based knowledge) from generalist investors (low level of network-based knowledge) (See Figure 16).

![Figure 16 – Investors’ knowledge types and funding categories](image)

Note: The structure of the knowledge stock plus the concentration of investment funds in a given sector distinguish dedicated from generalist investors.

Source: Author’s own elaboration

The quality and composition of the knowledge and the Knowledge Consolidation System of dedicated investors (top right quadrant) is complementarily characterised by a high concentration of funds in one particular sector (following the criteria proposed by Norton and Tenenbaum, 1993, and Rosiello and Parris, 2009).
Moreover, generalist investors, that may be specialised or non-specialised (that is to say, the remaining three quadrants), spread their investments across different sectors.

An interesting issue here is that investors can move across the categories. Specialised investors can become dedicated investors and vice versa. Such a transition is based on the gradual increase/decrease of the learning processes and accumulated knowledge about a sector based on relevant networking (De Clercq and Dimov, 2008) and the concentration/de-concentration of investments. It may prove a bit more difficult, however, to go from ordinary to specialised investor (moving from the low left side to the low right side of the diagram) and much more difficult to turn an ordinary investor into a dedicated one because it implies two heavy undertakings: completely transforming the knowledge and their Knowledge Consolidation System (IKCS) (technical knowledge about finance and network-based knowledge about a sector) and, consequently, focusing investments on a given sector.

Nonetheless, an interesting possibility concerns the top left quadrant. Investors who possess a high degree of sector knowledge based on experience and networking (such as scientific founders) can become dedicated investors with relative ease, if they acquire the necessary financial technical knowledge and provided that they have “enough” funds to invest. Indeed, it is not unusual for a start-up to grow into an established company and then to set up a corporate venture capital fund to sponsor investment opportunities in its own or close sub-spaces. This all serves to highlight the possibilities of evolution that are included in this explicative model of investment in innovation.

Finally, we draw attention to the fact that the learning-based depth approach of dedicated investors is also coherent with O’Sullivan’s claims that “… there are no objective guidelines for making strategic decisions about the extent, direction and structure of the learning process nor for resolving disputes about the strategy for learning” (1998: p. 185) when it comes to high level innovation. In fact, we consider that dedicated investors’ strategic decision-making can be labelled as “learning-on-the-spot” and is consistent with their involvement in very early stages of the projects/companies. Furthermore, such extremely early involvement of dedicated VC investors in order to learn, help shape and manage highly innovative projects/companies may also be considered an appropriate response to O’Sullivan’s allegation that decision-makers who shape the innovation process “… require
control of resources if they are to commit them to a developmental process in accordance with their evaluation of the problems and possibilities of alternative learning strategies.” In fact, this “build-the-path-as-you-go-forward” method is imposed to innovation players by the constantly changing circumstances of the innovation environment.

In short, making decisions about investment in innovative companies, particularly in science-based sectors such as bio-pharma, involves some serious challenges. In the particular case of VCs and other similar funders, their knowledge and their Knowledge Consolidation System includes technical knowledge about finance and expertise regarding technologies, markets, and products, as well as networks that comprise sectoral experts and other investors with analogous interests. Yet, VC investors also usually face information overloads in their attempt to fill up the information gap, high uncertainty regarding the successful outcome of the projects, unusual situations (e.g., about the project, the team, the macro environment), and time pressure related to the best timing for entering and exiting investment opportunities (Norton and Tenenbaum, 1993; Baron, 1998). This all is bound to affect their strategic approach to investing.

Essentially, what we posit here is that two VC investors may configure and use their knowledge and their Knowledge Consolidation System (IKCS) differently so not only their strategies will diverge but, in the end, they will belong to different categories of investors. Some authors contend that VC investors are bound to develop two different strategies: specialisation and diversification (Norton and Tenenbaum, 1993); such strategies, we propose, are related to other different characteristics and behaviours and give in point of fact way to two different types of investors: dedicated and generalist.

\[c. \text{ Some further issues}\]

The ideas presented above about the diverging types and strategies of potential investors related to bio-pharma SMEs and start-ups entail two conceptual discussions of relevance.

In the first case, the diversification strategy adopted by generalist investors implies that the diversity of stage-related investments should be a feature of the scope approach based on the selection of the best ventures across a wide number of
industries. Moreover, this is consistent with the standard financial literature on risk diversification. Yet available evidence indicates that generalist investors prefer late stage investment opportunities due to lesser uncertainty and risk, shorter time to exit, and closer distance to market which implies, all in all, quicker albeit smaller profits. On the other side, although dedicated investors should specialise in one specific financing stage, we learn that they actually deal with more than one as they can be involved in ventures from the very early stage (project inception) to the latest stage (taking a new product to the market).

This can be explained by the conjunction of various elements described above. An adjusting time horizon and timing concept about a particular venture and a particular investment structure where “crystallisation” and follow on investment schemes are present along several funding rounds (e.g., Norton and Tenenbaum’s (1993) fourth hypothesis explicitly includes follow on investment) can help to elucidate this apparent conceptual contradiction. In fact, an investor that helps shape the very business idea and accompanies the venture owners along the different stages (pre-clinical and clinical tests, pre-registration, registration and market development), due to timing and investment horizon (plus the appropriate pocket depth) considerations that give rise to follow on investment, may end up accumulating experience about more than one stage, thus adding diversity to the first-hand knowledge accrued.

A more difficult issue regards the tension created by the fact that depth-based investors (learning and shaping strategy) are active in a space (the very early/early stage) where the number of potential ventures is much bigger and entails the greatest uncertainty and risk because the attrition created by self-selection and external selection has not taken place yet. In fact, the accumulation of experience and knowledge in such a case seems obviously more difficult and costly, which would strain the capabilities of dedicated investors to the limit. Maybe, the answer lies in understanding better the reach and power of networking and the type of knowledge it allows investors to incorporate in order to make better decisions at the right time (e.g., modifying or even killing a project as soon as specific evidence on its feasibility is collected and assessed).
5.4 Some implications

The explanatory proposal advanced here has a number of implications in different aspects connected to the funding of innovation in knowledge/science-based sectors. The fact that the roles of the players and their interactions are heavily influenced by knowledge and networking is worth considering beyond the bilateral relationships; the importance of the IKCS in the strategy of external financiers of innovation, for instance, gives rise to the distinction between dedicated and generalist investors and helps to determine the institutional financial layout (IFL) in a particular context or, in other words, how much funding (how many financiers and how much money collected by them) is available in an economy to finance innovative projects in specific sectors, particularly if these are science-based.

Thus, policy-makers should be aware of these issues. The co-evolution of the circumstances that contribute to determinate the presence or absence of potential investors in the “market for innovation funding” (knowledge and IKCS included) during a given period of time brings forth some questions about the role of incentives and policy. For instance, how could/should path dependent investment trajectories (especially of dedicated investors) be modified in order to enhance the availability of funds? In other words, how to bring new investors into the game of innovation funding in a sector when their knowledge and their IKCS do not match that sector properly? What is the best manner to attract lead funders (usually, dedicated VCs) so that they entice followers (generalist investors or others) to tag along by signalling worthy investment opportunities?

Also, public policy has a say in complementing (filling up funding voids, beyond grant issuance) and inducing available funding (signalling). This implies playing a role based on proactive/reactive stances according to the circumstances. Additionally, innovation funding can also be supported, as particular examples have shown, through a public procurement policy that, in the case of science-based sectors, demands serious particular considerations (e.g., the role of national health systems in the case of bio-pharma).

Clearly, the availability of funding sources is a greater and more complex issue. Co-investment, another network-based funding issue, is also about the way in which the syndicate rules are built and then enforced towards a satisfactory outcome. But the
structuring of syndicates is simultaneously connected to other forces in the sectoral milieu: regulation, institutions, public policy, to name but a few. A dynamisation initiative may be led, for instance, through the promotion of increased diversity and intensity of network links related to the knowledge and the IKCS so that the acquisition effect becomes greater for a given space or sub-space (greater depth approach). This may implicate a need for design and implementation of very specific and focused policies and incentives to induce substantially greater very early stage investment (pre-seed and seed capital), for example (in support of Norton and Tenenbaum, 1993).

Moreover, the expansion of the range of funding sources gets as far as understanding how can the knowledge and the IKCS driver be used to help other funding mechanisms become actively involved in the funding of innovation. IPOs, for instance, and the role of specialised and general stock primary and secondary markets can be mobilised and enhanced by appropriately dynamising the participation of a number of dedicated investors that may, in turn, induce and lead generalist investors (common ones included) to aim a given innovative sector as their investment target.

Further implications may be drawn from a systemic view concerning the role of public policy in connection to international funding (e.g., foreign, especially corporate, VC related to M&As) and IPOs (e.g., listing innovative companies abroad), particularly after the European experience with technological markets, and the possibilities of new financing sources and mechanisms (e.g., technological crowd-funding).

Once again, policy makers interested in incentivising the development and availability of high risk finance to support sectoral innovation may also use this view, particularly the trade-offs involved in project stage interest (early/late)-approach (learning & shaping/selection)-capabilities and commitment, to examine the best potential drivers and courses of action to increase potential investors’ interest and experience in such an activity and venture owners’ strategies to approach external funders according to the sectoral specificities.

With regard to science-based innovative firms and potential funders (and their respective managers), the potential influence of the network-fed KCS in a sectoral
system described here is, in a way, a concrete confirmation of McKelvey et al’s. (2004) statement that networks of actors and their relationships can significantly elucidate the behaviour of individual firms and industries, in this particular case in what regards the central role of external financiers of innovation in bio-pharma (and, by extension, in several knowledge/science-based sectors). Most of these topics, however, demand further and deeper study in the near future.

Above all, not any type of funder for any type of project seems to be the “rule of thumb” in the world of innovation, particularly in science-based sectors. Generalist and dedicated investor categories may mean a need for different approaches from innovators/innovative organisations, instead of just “looking for anyone’s money at any time”, and even maybe an entirely different range of mechanisms to fund bio-pharma and other science-based sectors where the VC/BA funding plus grants scheme falls short or is not fully appropriate because of its characteristics. Firm managers may need to ask themselves (and their organisations) if it makes more sense to target dedicated or generalist investors under certain (particularly harsh) circumstances, and how to do it more efficiently given that from our view it follows that dedicated investors may be more committed and have more “momentum” than generalist investors, which can retreat more easily.

Additionally, innovative firm managers would do well to value their own networking efforts since these could facilitate and, to an extent, even substitute transactional intermediation to approach appropriate potential funders and to sell projects more easily by bridging knowledge gaps and creating trust more speedily, thus building valuable track records for future fund raising activities.

Also, co-investors may benefit from considering what type of partners is more convenient so co-investment structuring and follow on perspectives may be strengthened. Such beneficial analysis could spread, for example, into a more auspicious combination of government and private funding initiatives/mechanisms for innovation, especially in some sub-spaces where speedy changes are taking place (e.g., the development of personalised therapies).
5.5 Final remarks: A systemic view of innovation funding

The issues dealt with above lead us to think that the decisions that regard the financing of innovation, at least in what concerns science-based industries such as the bio-pharmaceutical sector, are not made by a single party and on the basis of only such a party’s considerations and preferences as most explanations have proposed so far.

Fund raising decisions on the side of innovative entrepreneurs/companies take into account a number of factors such as the costs (not just the rate of interest, but also other costs associated to time and information), the availability of effective funding options, the accessibility of such sources and mechanisms, and the strategic convenience of settling a particular deal. Such factors vary according to the case; pre-organisation ventures (projects still without a firm behind them) and pre-revenue start-up companies (sometimes consisting of a single innovator) may not have any internal funds (although serial entrepreneurs may have stashed some) so they are pushed to seek external financing; established companies with revenue and even some profits, in contrast, are in a different position. Companies with IPRs granted have an advantage over companies without them, just like companies with a track record and a rather good network of contacts in the sectoral “ecosystem” are better positioned than brand new companies with few or no demonstrable experience and networking. So, the matrix resulting from combining all the relevant variables can really be vast and complex.

From a complementary viewpoint, it is necessary to bear in mind that innovative entrepreneurs/companies may seek funding for their projects for a number of reasons. On the financial side, either they lack internal resources completely or partially or, even if they possess the resources, the management decides that it is strategically convenient to look for external funders because of the uncertainty/risk profile of the project (risk sharing) or simply because the use of their own funds is a second best (i.e., they can be invested in a less risky albeit less profitable project or external funds may be less costly than internal ones). On the strategic side, they do so either because they can use such a channel to bring about some knowledge or capabilities that they do not possess (e.g., joint ventures or VC financing) or because that is their business model (e.g., sub-contractors that do R&D for other companies). In any case it seems that, when there is a combination of reasons, the financial goals
of the parties are generally dominated by their strategic objectives (Dushnitsky, 2006; Basu et al., 2011).

The main issue here regards the fact that innovative entrepreneurs/companies do not build up their strategic approach to fund raising on the basis of their internal reasons and preferences alone, but they have to take into account the conditions of the “ecosystem” in which they are located. Looking for funds is not just a question of where (which source? VCs or banks or even other companies, for example), it is also a matter of who (which type of investor? governmental or private; BA or VC; corporate or independent, for instance) and under which kind of contract (e.g., loan, investment, sub-contracting). The potential choices are, however, affected by contextual factors such as regulation (e.g., funding schemes, benefits or restrictions established by law), competition (e.g., number and quality of national and international financial players interested in the sector), macro-economic conditions (e.g., abundance or scarcity of VC money), and institutional design (e.g., existence of a specialised stock market) among others.

Also, investing decisions on the side of funders are not only concerned with where will they place the funds (which company? which people?), but specifically about what preferences the investors themselves feature concerning a particular sector and type of project. Stage, investment structure (stand alone or co-investment, one-off or follow on), exit mode, investment horizon, and timing are all relevant factors in such a decision.

Investors also have their own reasons that range from purely financial (i.e., a profit rate that conveniently matches the risk profile of the project/company in the case of financial investors) to essentially strategic ones (e.g., internalising knowledge and capabilities, externalising certain functions or outmanoeuvring competitors as is usually the case of corporate investors; boosting a sector to create jobs and increase value-added exports in the case of government investors), though they usually conform a mix that helps to shape the strategic approach to the investment.

Therefore, we propose that the established literature on the financing of innovation (see Chapter 2) can be thought of from a different perspective and, thus, be enriched. To begin with, the general array of external financing sources that may theoretically support innovation includes government agencies, specialised investors, established
companies, banks, and non-specialised investors. These can provide funding under many different mechanisms: from subsidies and grants, to loans, to venture capital and equity investment. However, effectively available (in terms of pocket depth and readiness to fund certain project stages) and most sought after sources of funding for bio-pharma innovative companies (and companies in science-based sectors in general) differ in the case of start-ups and established firms (Ullah et al., 2009; Haslam et al., 2011) according to the different national contexts (Casper and Kettler, 2001).

Furthermore, we propose that a sectoral characterisation of the core bio-pharmaceutical sector proposed so far (Powell et al., 1996, 2002; Liebeskind et al., 1996; Kenney, 1998; Malerba, 2003; McKelvey et al., 2004), and possibly that of other knowledge/science-based sectors, can be enriched by including an analysis of how innovation is financed in such industries. That can be done, initially, by taking into account the venture owners and the Investors’ knowledge and their Knowledge Consolidation System (KCS) that involves, other than the “knowledge underpinning firms’ innovative activities” (Malerba, 2002: p. 252) (that is, the knowledge base concept proposed by Norton and Tenenbaum (1993) and Malerba (2002)), all the knowledge about fund raising and about innovative project management.

We also emphasize the existence and effect of investors building up their own knowledge and Knowledge Consolidation System (IKCS), which is organically connected to the core knowledge system of the industry (the innovative firms’ KCS that exceeds Malerba’s knowledge base as explained above); it means that not only have the knowledge and the KCS to be considered to be wider (at least in the case of science-based sectors), but that the enhanced and evolving knowledge and KCS have a strong influence on the funding of the industry’s innovative activities. This is so because it is a factor behind funding availability and readiness for innovative projects in the sector and because it sort of steers the strategy of both venture owners and funders, and possibly also that of other actors, regarding the financing of projects.

A few questions may help us understand the complexity of the strategic decisions behind funding innovation. Why, for instance, would some companies look for external funding even if they possess internal resources to invest in innovation? Why would innovative companies seek VCs or BAs if their commercial bank is ready, at least theoretically, to support them? Why do some innovative companies prefer
going to State agencies or charities (where available)? Or, even better, why do some companies, which have used a particular source/mechanism successfully in the past, change their funding preferences or look for new financiers?

A rather straightforward answer involves two variables: time and change. The investees’ needs are not the same all along the innovation cycle, nor over the cycle of firm maturity. Start-up firms are different in many ways from young established companies and from mature companies (e.g., experience and track record, network contacts, knowledge system); but also early or late stage projects mean different things to different types of enterprises. On the other side, the effective availability of funding sources and mechanisms changes over time as well. Particular types of VC funding may be abundant at certain times and scarce at others (e.g., corporate VC for M&As or IPO investors) and, then, the links to and accessibility of such sources vary with each individual venture owner.

There is also the fact that co-investment syndicates in many cases may involve different types of sources and mechanisms (e.g., private and government seed capital, business angels and independent VCs, corporate VCs and investment banks); such a trend may help to create (at least potential) advantages in terms of the so-called certification effect that can be beneficial over time for the purposes of raising follow on funding as long as successful milestones are achieved, for example.

Moreover, in the case of bio-pharma companies intended to be IPOed, it may be the case that potential investors (specialised or dedicated) need to be somehow attracted in order to create a more liquid demand for the stock even in the secondary market. Thus, the knowledge and the Knowledge Consolidation System, as well as the signalling mechanisms (non-dedicated investors fit better the role of followers, not that of leaders), seem essential to counter short-termism and an eventual free fall of share prices that usually lock in the original venture financiers.

Additionally, regulation and other institutions and their modification over time may also help change the strategy (mediated by the characteristics and preferences) of both investors and investees. For instance, new incentives or protections (or the elimination of those in existence) offered to specific players may modify their availability to take part in the funding innovation game. The trust and the channels for the transfer of knowledge built up through long-time networking and a positive
track record of commitment and success may facilitate and even obviate the need for formal contracts, at least in some stages of the relations among funders and project owners. And, of course, the disappearance of such conditions may produce the opposite effects.

So, in short, it all depends on organisational (i.e., companies and investors’) characteristics (including their knowledge and their Knowledge Consolidation System and network participation), reasons and preferences that may mutate over time (co-evolution) and in accordance to surrounding macro and sectoral circumstances. The strategic behaviour of the actors involved in the financing of innovation in bio-pharma, and possibly in science-based sectors in general, is related (determined?) to their interactions (where networks are essential) and to the conditions under which such interactions take place. After all, as Myers and Majluf (1984) made clear about their POT, an explanation and its conclusions are dependent on the assumptions specifically created for the model analysed which, in most cases, is just “...one of many possible stories about corporate finance. A full description of corporate financing and investment behavior will no doubt require telling several stories at once.” (pp. 219-220).

Thus, many a current explanation about the funding of innovation can only be theoretically normative because there are several factors in actual reality that readily alter any “prescriptive” behaviour (e.g., selection or inducement approaches)\footnote{This would help explain, for instance, the “reversal” of the ranking of funding preferences of innovative companies in several industries and, particularly, in the bio-pharmaceutical industry (Saltari and Travaglini, 2001; Hogan and Hutson, 2005; Ullah et al., 2009; Cassia and Minola, 2011) and other science-based sectors.}. Moreover, since investors (particularly knowledge-based ones) can move in and out of certain spaces/sub-spaces, the systemic dynamics is even more complex.
6. CONCLUSION

In short, this piece of research proposes that the extant approaches to the explanation of innovation funding in general, and in the bio-pharmaceutical sector in particular, are insufficient because of a number of shortcomings: they mostly focus exclusively on one side (either the venture owners or the potential funders), they consider only the criteria and preferences of that side, and they vastly ignore the milieu in which the funding decisions are made.

Furthermore, those explanations sidestep the roles of other actors and, besides, mostly consider the main actors to be firm organisations, whilst a close look at reality indicates that many are individuals or pre-firm organisations.

In the specific case of innovation studies’ views of the bio-pharmaceutical industry, a more reasoned approach that has produced a more integrative perspective (namely the Sectoral Systems of Innovation perspective) has essentially skipped the role, interactions, and decisions of innovation funders bar an episodic mention of the necessary involvement of the financial sector.

We expand the SSI view on bio-pharma by articulating the consideration of different types of funding-related actors that play several different roles mostly, but not solely, on the basis of their appropriation and use of knowledge about the sector. Essentially, we expand the “knowledge base” concept, explain the existence and role of a system that allows for the incorporation and articulation of new knowledge by different actors, articulate the participations in networks into such Knowledge Consolidation System, characterise potential funders, and propose an explanation of how their strategic behaviour produces two entirely different types of potential financiers.

Finally, we also discuss some potentially key implications and offer a systemic explanation of the funding of innovation that may, potentially, be extended to other science-based sectors.

6.1 Contributions and implications

Unlike most available explanations so far, we consider financing innovation to be better accounted for by a systemic view that, among other things, takes into account the motives, the decisions and the interactions of different players (mainly, but not
only, the project owners and the potential external financiers) in a particular context. Thus, our proposed explanation is closer to, and in several ways complementary to, the proposals of Malerba (2002 and 2003) and McKelvey et al. (2004) concerning the bio-pharmaceutical sector in particular (bio-pharma as a sectoral system of innovation - SSI).

This proves an effective way to avoid the bias (one proactive vs one passive side), the imbalancedness (domineering criteria set by proactive side) and the disembeddedness (narrow and broad milieu factors and changes unacknowledged) that characterise the present explanations: Pecking order theory (Myers and Majluf, 1984; Ullah et al., 2009; Mina and Lahr, 2011; Haslam et al., 2011; Bertoni and Tykvova, 2012); passive search theory (Eckhardt et al., 2006; Chan, 1983; Amit et al., 1998; Gompers and Lerner, 2001; Knockaert, Clarisse, and Wright, 2010; Bertoni et al., 2011); catalysing strategies theory (Hallen and Eisenhardt, 2012; Hallen, 2008; Gulati, 1995; Gulati and Higgins, 2003); and active search theory (Chan, 1983; Amit et al., 1998; Gompers and Lerner, 1999 & 2001; Knockaert, Clarisse, and Wright, 2010; Bertoni et al., 2011; Bygrave and Timmons, 1992; Powell et al., 2002).

In more detail, our explanation proposes that innovative science-based (e.g., bio-pharma) firm and pre-firm organisations’ knowledge goes beyond that knowledge necessary to create new processes and products (what Malerba (2002 and 2003) and McKelvey et al. (2004) call the knowledge base) and includes knowledge about funding (locating and negotiating deals) and managing innovative ventures (hands-on experience and learning from funders’ coaching), too.

Investors’ knowledge, on its side, regards their financial technical knowledge, their knowledge about the core sector itself (i.e., science and technology, products, firms, markets, and institutions), and the knowledge needed to network with sector experts and other investors with similar interests in order to update the two previous types of knowledge.

Also, we propose that both project owners and investors have their own Knowledge Consolidation System (KCS) that allows them to update the “stock” of knowledge accumulated through past experience and learning and lets them also incorporate flows of fresh knowledge that is acquired from different sources through different networking possibilities or by hiring knowledgeable staff. Both, the firms and the
investors’ Knowledge Consolidation Systems change over time, partly due to the changes in the knowledge available (e.g., new research outcomes, new financing mechanisms) and partly due to the mutations of the setting (e.g., changes in regulation, emerging actors/roles) that demand continued learning by both parties in order to cope with such changes.

Another feature of our proposed explanation regards the existence of an institutional financial layout (IFL) in any given setting (e.g., economy) where bio-pharma (or any industry) is active. The IFL depends on the availability of funders and their readiness to finance certain ventures. In short, funding availability and readiness to fund innovative projects are strongly affected, we propose, not only by milieu-related factors, but also by concrete investor’s features such as their investment base, their preferences for stage of investment, their time horizon of investment and investment timing, their preferences about the exit mode, and the preferred investment structure for each particular deal.

Hence, the interactions between venture owners and potential funders are deeply impacted by their own characteristics and preferences, but also depend on their capabilities to effectively network and, thus, enhance their knowledge and their Knowledge Consolidation System. This is particularly important for investors and their IKCS.

In fact, we propose that the distinction between funders (individuals or organisations, private or public, national or international) is not due to a simple variation in their concentration of funds (what percentage to put in a given space or sub-space) or the location of their investment strategy (where to place those funds in terms of geographic area and specific organisations), but it has to do with a deeper distinctive approach regarding their interest in and their knowledge about a space (sector or sub-sector) that can be described in terms of wider scope versus deeper reach of knowledge about potential investment opportunities in given sectors (learning and shaping vs selecting).

Greater interest in deep knowledge about one space (industry) implies a greater networking effort to acquire the necessary knowledge through greater intensity, diversity and acquisition effect of networking formally or informally (e.g., contracts, formal consultancy or informal advisory). Thus, the resulting knowledge and
Investor’s Knowledge Consolidation Systems (IKCS) of two funders that decide to follow different knowledge acquisition paths (wider scope vs deeper reach) give rise to two different types of investors: dedicated and generalist (specialised and non-specialised is only used here in reference to their financial technical knowledge regarding investment).

Therefore, the basic difference between types of investors in bio-pharma, and science-based sectors in general, lies in a different approach to knowledge and, thus, a different IKCS. That also generates differences in terms of the roles played concerning fundees (e.g., monitoring, signalling, coaching, and some issues regarding the funding itself such as the time length and the amount). Finally, we propose that investors may move from one category to another by essentially, though not easily or cheaply, adjusting their knowledge and their IKCS accompanied by the spreading (more or less) of their funds concerning a particular space or sub-space.

This systemic view, we consider, is much more complete than the essentially one-sided explanations advanced by the previous literature and, also, complementary of the SSI-approach in two senses: first, it explains a particular issue, the financing of innovation, that SSI proposers do not deal with, and, second, it enhances the SSI approach both conceptually (new constructs are defined and others are enhanced) and organically (new working mechanisms are defined). Moreover, the implications and new research avenues here described open up the possibilities of effectively making a systemic view of innovation stronger and fitter to explain what happens in the real world.

We consider that this explanatory model about the funding of innovation can be extended to other science-based sectors, with appropriate precautions, in order to improve its understanding and the way funding works. As long as some characteristic traits show up, our systemic explanation can be usefully applied to enhance the knowledge and support the practice and policy-making that concern such sectors; it would be interesting to see, for example, how well our explanation fits the funding of innovation of sectors both, relatively close to bio-pharma in different respects (such as medical software or medical devices) and relatively away from it (such as other tailored software, ICT, nanotechnology applications). We think that this systemic view of innovation funding has a lot to offer in terms of understanding what works
(and how it does) and improving what does not in science-based sectors where fund raising is a hard issue.

In fact, the emergence of new knowledge and the dissemination of fairly new knowledge towards lagging contexts as the basic input for innovation, accordingly different but persistent levels of uncertainty and risk, as well as a given time horizon (and, therefore, the importance of development stages) before outcomes are materialised, are the norm in many innovative sectors; also, the prevalence of information gaps, intangible assets (at least in the initial stages of project development) and relatively high costs that can barely be upheld by a single player, the existence of several different actors (e.g., private and public, big and small, local and multinational, organisations and individuals) other than the venture owners and the potential investors, and the emergence of dynamic institutions (e.g., regulation, IPRs, bottom-up initiatives and sector-specific organisations with diverse scopes, networking, demand) in differentiated milieus are common features of several science-based industries. Yet, differences in these and other traits (e.g., the time horizon and stages of projects, the level of financing required, demand and markets characteristics, path dependence in certain activities and behaviours) may require an adjustment of the explanatory mechanism.

What does this all mean for research, policy-making and professional practice? In terms of research about the funding of innovation in specific science-based sectors, we think it is necessary to do as many sectoral case studies that explore and determine the specificities of each space and sub-space as necessary to cover the most relevant sectors and settings to help make this explanation consistent and relevant. In terms of policy-making, we consider that a thorough understanding of the sectoral peculiarities in terms of innovation funding will essentially contribute valuable knowledge to decide if and when one-size-fits-all policy can be designed and implemented or when sectoral policy suits better the reality of a given space or sub-space in a particular context (e.g., when and where should public funding complement or compete with private financing, to what extent, and through which mechanisms). Finally, practitioners of all types will benefit from extending this analysis of innovation financing to other knowledge-based sectors by enhancing their understatement of the players, roles and circumstances such that their interventions and tools are more fine-tuned with the real needs of a given industry and group of
actors and, thereby, waste of resources is diminished and efforts are used more appropriately, and more pertinent goals and outcomes are set and pursued.

6.2 Limitations

We consider that the main shortcomings of this piece of research have to do with: *i*) the need for coverage of cases in radically different settings (e.g., developing economies where science-based sectors are also present but may face particular challenges such as weak science and technology infrastructure and sectors where innovation funding involves different characteristics such as shorter time horizons or lesser funding requirements); *ii*) the need to ask about and discuss specific innovative projects on which both venture owners and funders are ready to release information and contribute views so a clearer view-based project within a particular space contributes further relevant information.

The first issue would help to check the robustness of the theoretical explanation proposed across a number of variables that are likely to affect different settings in substantially dissimilar manners. That also means that studying science-based sectors with radically different characteristics (e.g., parametric uncertainty, shorter project development time, lower budget needs), as opposed to bio-pharma for instance, would allow to consolidate the “lateral” strength of the rationale underpinning this explanation, that is the systemic nature of the core explicative constructs and their operational gearing.

The second matter, if viable, would help to understand certain specific relations, interactions and mechanisms, sometimes created *ad hoc*, that may allow further refinement of the explanations proposed as long as more fine-grained views and discussions are prone to generate a better understanding of factors highly specific to a given situation or moment that illuminate the rise of unusual difficulties or outcomes. This point is very hard to achieve, though, given the highly secretive nature of R&D in science-based industries and organisations since the protection of specific knowledge is the very basis of the innovative activity and its final success, at least to the extent where IPRs are clearly established and cannot be challenged.
6.3 Further research

Several issues could follow from the discussion and proposal set up here. Beyond the two issues described in the two sections above, a number of other topics require further enquiry to draw a more precise picture of innovation financing in science-based sectors, bio-pharma included. For instance, the availability of funding sources (the Institutional Financial Layout of a particular setting), co-investment among generalist and dedicated investors with a government and a private background is a topic that deserves greater attention given the current trends and circumstances. Clearly, it is not just a matter of discussing whether there is any crowding-out or a certification effect, but the main issue is more about how to better articulate resources to support an activity that is key for economic development and for the healthcare systems around the world and, furthermore, to establish how returns on public funding should be mostly secured for society and not be mostly captured by private players (e.g., public grants conceded to very early and early stage ventures), especially given the nature of the funding and, therefore, the production of basic knowledge in most countries where bio-pharma and other science-based sectors are important.

Connectedly, a discussion on the role and importance of corporate and independent VC and variants, the growing role of charity funding, as well as the importance of business angels in science-based sectors such as the bio-pharmaceutical industry, not to mention the exploration of potential new alternatives such as crowd funding ensues. All these factors may alter even more profoundly the systemic configuration of innovation development in different settings in the near future.

Also, the role of public policy to strengthen the necessary type of investments according to the harsh circumstances that surround science-based sectors worldwide and in each national setting (e.g., developed and developing countries) currently may be a topic to develop starting from this proposal, as well.

Finally, a validation of this explanation for other science-based sectors where traits such as uncertainty, risk, time horizon and funding needs be radically different (e.g., highly specialised software development) may also add to the robustness of the explanatory ideas here advanced.
7. REFERENCES


Department for Business, Innovation and Skills (BIS) (2010) The 2010 R&D Scoreboard. The top 1,000 UK and top 1,000 global companies by R&D investment. (Downloaded at www.bis.gov.uk/randscoreboard)


### Table 9 - Knowledge about sector – excerpts from interviews (a)

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<td>... I think the people that are left do either know themselves or recognise that can get somebody in who knows about the technology. Without that, people do not tend to invest if they don't know something about what they are investing in anymore...</td>
<td>... you're working with the leading edge piece of technology, globally, and there are a handful of people that understand what you are doing at the detail, detail... and sometimes even just one or two.</td>
<td>The funders actually are very careful with their money and they do a lot of due diligence before investing.</td>
<td>You can only have good results if investors have some knowledge and are enthusiastic about science. Only people who are passionate about science will invest money in that sort of projects today.</td>
<td>... when we talk about VC, we talk about a lot of different specialists, anyway, some of them will have the specific knowledge about... or certainly the contacts to be able to find the right set of technology, to make a good assessment.</td>
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<td>... a lot of them, the investors in the sector, are hands-on investors so they take direct seats on the board. So it's not just money... it is 'we are going to come because we can add strategically networks-wise'.</td>
<td>We cannot know everything about things that we invest in but we do tend to have things developed.</td>
<td>... we are only six people, so we, of course, cannot know everything. So you have to be humble. That actually goes for whatever you are doing, humble about what you know, especially what you don't know and be realistic about that. I still think there is a lot of common things (sic) that you can carry from one area to another area because, I mean, the basic operational needs of a biotech company, the basic need to address unmet needs or unmet regulatory concerns, the different areas have the same sort of perspective on that. But we try always to engage on the board someone with domain knowledge and experience and we, of course, use consultants in the companies...</td>
<td>... it has advantages if you are acting in one area or if you have looked cross way at a particular area when you get something new because you are learning and quickly can decide if that is good or bad and if you decide to invest, you have more experience to help the company with. So I think in our firm we have recruited the investment managers that have operational backgrounds and we try to have them complementary to what we would have, knowledge from different parts of the process of creating drugs, you know, anything from the R&amp;D field to clinical developments or making (??), as well as having wide and different therapeutic areas so that it is possible for us to have at least some level of expertise...</td>
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<td>... it [knowledge about the sector] is the foundation of your investment business, really. And I think your domain expertise is critical... each deal you do gives insights into</td>
<td>I think it [knowledge about the sector of investment] is very important. It is key. We spend a lot of time on catching up with different fields if we are presented an investment</td>
<td>... there is sort of two different sources of knowledge that are really important to do this job well. One is absolutely sector and market knowledge, but we also think that actually knowledge of...</td>
<td>... successful investors all have people on the... people on their payroll to have a... extant experience in both science and medicine and business. It is really</td>
<td>... To go out and see opportunities and to form a company yourself... around interesting science requires a great deal of knowledge, I think, within the team. ... everybody in this...</td>
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other deals through…
through the things
that get well and the
mistakes you make as
well.

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<td>other deals through… through the things that get well and the mistakes you make as well.</td>
<td>... no individual person can have all of the knowledge that is needed to assess a project, so… if you are an investment professional specialising in therapeutics… therefore you have reasonable time to build a background and reasonable medical knowledge of the… the team members, and markets, and drug discovery… ... and my background degree… doing research and drug discovery so I know about that from my previous jobs and I keep up to date with the field by reading journals, going to scientific meetings, speaking to people… then the… the commercial side of things… that is, knowing the markets -and you can object that is real experience-, talking to people, sitting on the boards of good portfolio companies with people that have commercial industry experience and know the marketing of products…</td>
<td>... VCs in health care are… you know, typically have PhDs and (?) who can come up to speed very quickly. They are going to know what… will also be very familiar in a particular therapeutic area whether it is oncology or infectious disease or basically whatever. They are going to have a very good idea of what to look for, very typically keep up with the literature and so… they are going to be able to understand and communicate with experts in the field, domain experts such as a professor or researcher in that particular area.</td>
<td>I would say that [knowledge about the industry. It is really important. business has scientific advisors and consultants because no matter how smart the team is, there is going to be fields that where you don’t have absolutely, you know, cutting-edge tip-top expertise. But, it seems to me that it is possible, if you are principally a follower, to have a team that is made up of folks who are primarily financially oriented who use consultants to tell them the things that look interesting are in fact scientifically interesting.</td>
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<td>basically being a good supporter venture capitalist… knowing how to work with companies, teams, build teams, build businesses’ plans for exit.</td>
<td>critical … you can’t be successful in this game without knowledge of the sector. ... Quite a lot of investors have people inside them who have no experience in science and in running these businesses; they are more financial … you really need to understand the dynamics and the issues that confront the industry. It is really important.</td>
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<td>I would say that [knowledge about the sector] is a major factor because I think that mostly in bio-tech is… there is too much science in it for somebody who has no experience to really understand. For sure [a funder’s previous experience is a major factor]; I think that they really could not understand what we were doing if they did not already have experience in our space.</td>
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Source: Author’s own elaboration
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<td>Some [investors] are specialists, some are non-specialists, and if they're specialists then clearly they have sectoral expertise. But even if when they have sectoral expertise, they rarely have the level of detailed expertise that we have for the innovation or the technology.</td>
<td>“It is limited [investors'] knowledge] since the scene is very high risk. Therefore, there's probably around only a small number of VCs who specialise in this area and they would probably do it either on a European or a global basis rather than just the UK.</td>
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<td>... we try to sort of accumulate knowledge so, for instance, in NS we have now 3 portfolio companies working in the anti-infective space; there is none of us who actually have a background in that area, but now we work on several portfolio companies so, although we'll never be anti-infective experts personally, at least we know some of the things to look for and have some kind of network in that area.</td>
<td>... we raise money from our investors on the back of being experienced pharmaceutical executives. So... certainly in the London office we would never try to branch out into vaccines or into diagnostics or anything like that because we simply do not understand the sector. And when some of our colleagues have tried to do that, particularly in America where they tend to think they are invincible, you know, you get into real trouble because... you know, these are very, very difficult areas in terms of the science, of the technology, in terms of the clinical positioning, the commercial positioning. And you</td>
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Table 10 - Knowledge about sector– excerpts from interviews (b)
cannot do it as an amateur. Some people do and they usually fail. So we stick to the knitting, as they say.

greater difficulty in sort of evaluating our project and challenges and all that. [The other funds] are not [qualified], they don’t have a portfolio in antibacterials, but NNN… I think half of NNN’s portfolio is in anti-infectives, so they are very strong.

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<td>… for example, healthcare IT which is an interesting space at the moment, but we don’t have any experience in that space among our partners in the organisation as such, so we would say that is not our investment scope; it is an interesting opportunity, but no, thank you’. No, we would not do it even if there is some co-investor with experience in that particular area, we need to understand exactly what we do ourselves.</td>
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<td>… And it is not just a case of you are a smart person, you have got an MBA, you basically understand business analysis and you understand sectors and trends, then you can be a good investor; we actually think that is a part of it, but that is almost as important and maybe even more important as you get to later stage businesses is… is that ability to recognise patterns, to intervene to help get things back on track, to facilitate change in management teams if needed, and then to provide extra support for the teams if needed, and to have one plan… plan for exit, to work with advisors to… we think it is more of an art to do that that actually you can learn from experience and people.</td>
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<td>[Knowing people who have the expertise is critical.] I think it is OK in terms of moving within therapeutic areas, which is what you are talking about exactly. I think along as you can (talk) to a proper expert outside of… your particular company, I think that works fine.</td>
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<td>I think it is hard to be a lead and to… especially if you lead in company formation, without having… you know, sort of deep scientific understanding within the team… and I say that as a guy who is not a scientist… … I know a lot about starting companies, but I need to that and collaborate with people who can tell the really great science from the really good science.</td>
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<td>… you’ll get some [knowledge] just [by] doing deals, that is just experience that is not proper science, a little bit about company operations - which, again, you get from sitting on boards and being involved in the running of the companies… and then… and then everything else, that is the expertise on setting the market and maybe a bit of technology, and that kind of thing… you generally outsource that… … you speak to people, you often pay experts to conduct due diligence for you, you basically get in touch with other companies, talk to the technical people, talk to customers, talk to basically anyone you can who can give you their opinion on a technology or a market, that has experience of it.</td>
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<td>The most successful VCs are going to invest in an area in which they have some expertise, now they are not going be the world’s experts in the cutting edge… you know… new molecule, but they will know who to go to do their technical due diligence, they… about half of the people who make the investment decisions in the bio-tech space are actually CFAs, and so they have no scientific training, no medical training, yet they have been working in this space for twenty/twenty five years and they know all there is to know</td>
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<td>… I think that the information they have just helps them valuate whether the prospects for the product you are bringing to them are worthwhile or not. So, you know, I think without that knowledge, they just cannot make a very big surge in.</td>
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<td>Most of them [VCs] were dedicated, that kind of investors. Pretty much.</td>
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know what types of questions to ask initially to screen whether this is something truly novel or not.

… because they have so many deals, they establish the… your best VCs will have a very strong searching list of what has the prospects of being a successful investment.

… typically, they [VCs] won’t invest if they don’t know anything about it… if it is something somewhat peripheral to what they do know about, the only way they will get involved is if they co-invest with other VCs.

about drug development, what can go right and what can go wrong.

Source: Author’s own elaboration
**Table 11 - Networks – excerpts from interviews (a)**

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<td><strong>Most often, more and more often than not, there has to be a management team, there has to be one or two people, or at least one, who has industry reputation and that can point to ‘they do this, they do that’ and therefore it becomes easier for an investor to say ‘well, what would you think?’</strong></td>
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<td><strong>Very few [things are done on cold contact]... I would only do something like that if it was, number one, very interesting, and number two, there is a good management behind that. It does not really happen. Usually the stuff that is more common considered and real would come through an introduction.</strong></td>
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<td><strong>Most opportunities are introduced by advisors, corporate financiers, mostly generalists, attached to accountancy firms.</strong></td>
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<td><strong>... there are also universities in the region that have some sort of commercial arm that showcase bio-tech companies.</strong></td>
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<td><strong>So it is based on the so-called &quot;preparatory deal flow&quot; where a particular project looking for funding is not built up and shopped around a high number of VCs, but discussed with people with whom prior relationships exist.</strong></td>
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<td><strong>... as for funds that work on late stage financing, they know when they have a proposition in this sector (the bio-pharma space, such as a therapeutical proposition) they will need a lot of money to fund it. So one of the constraints when you are a VC is how big the fund is, how many people you’ve got, so how many deals you going to do (in) a year. If you are a brand name life sciences fund, you are going to have more than enough deal flow for the amount of deals you want to do. And that’s sort of unsolicited.</strong></td>
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<td><strong>A big reason behind the networking strategy has to do with the fact that it is such a broad field that even if you have a background in a given area in say, clinical developments or discovery research, you can’t be a master of everything that you need to know. You can go so far generically but these things are so specific that you still tend to need an expert...</strong></td>
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<td><strong>we do have very good relationships, clearly with IC (a university), we still manage the technology transfer business for IC and...</strong></td>
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<td><strong>we are constantly learning and trying to exchange knowledge within the group here and also, to some extent, with other investors.</strong></td>
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<td><strong>I go to the ones [funders] that fit best to that project... so you can look at the portfolio companies they have invested in, of course</strong></td>
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<td><strong>Well, I think, of course, they always engage with experts to evaluate a project, so that is sort of one reason.</strong></td>
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<td><strong>... to get into the late stage opportunities it is more about getting to know them over a period of time and getting to know the management team...</strong></td>
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so by the tech transfer office we see lots of projects coming out of this university at very early stages so that we can get our heads around for a long time; sometimes they take one to maybe three years to come out to the university and we have the ability to sit alongside our TTO colleagues and have a look at those opportunities and gaze them as they are growing or gaze them as they are evolving deciding whether that is something that constitutes a new investment opportunity…

We are generally very good at… we work close together and share… each of us have different networks and share that. … in NS we have a long standing track record in this industry and so all of us have big networks…

you know they have a specific target and so on for their investments. And then… you know these are the ones. [When they contact you…] then you get that quite easily, quite quick… you will get this information. [They find about you…] through different sources and then when you have the first meeting with them, they will tell you why they find your company or your project interesting… so essentially networking is central in this type of contact].

The other thing is that we have an advisory board so… people who are well-known and sort of well respected; and if these people have put their name on the project, then I think it sends a good signal.

when at the early stage; so often it is the management team, so you are not forming a view on people so much. And I think the networking actually is important for getting to know people and businesses, so I would say it [networking] is more important for late stage.

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<td>… we were going out getting our own deal flow, and then all the other firms were doing the same and, I suppose, we would be going into meeting the same groups, but not knowing who else they were talking to. But you do tend to… you tend to sort of share, I suppose, sort of… deal flow at an early point if you think that is a certain compatible investment strategy and you think ‘you guys have seen that company, you know… we are starting to do some work on it…’, you know, is that something that you are looking out and…’ you know, those are the kind of early conversations that can also lead to syndications.</td>
<td>… there is sources of technology – the universities’ network, there is sources of money – the financial networks, sources of management talent – that is the resources networks, then there is the network of industry players – which is companies or businesses making eventually these…</td>
<td>… lots of opportunities come through companies, people, other venture capitalists that we have worked with in the past.</td>
<td>… each of this [opportunities] comes from a different part of the industry and, you know, whether we are scientific, medical or any other background, I think that we have got some… some, deep knowledge, and people who are keeping up in those areas because that is their specialty…</td>
<td>… if we see something we like, we are probably, you know, especially if we are likely to do it, you know, we trust in our judgment in that area. In some other areas, you know, we need to go find somebody in whose judgment we trust. And my guess is that even when we do that, when we find someone that we have worked with before who is, you know, we think he is a real expert, we are still going to, you know, sort of need to do some learning out around and become at least temporary experts in the area.</td>
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Source: Author’s own elaboration
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<td>... YFM were one of the people they were already talking to and hadn't managed to secure investment, so we persuaded them and they then went on board and we got us a good relationship with them…</td>
<td>... I knew the chief executive of AAA from before, out of… I held an enterprise fellowship from YF that provided a fellowship that came with an industrial mentor who was the CEO of AAA. So that personal relationship that we had also made it very easy…</td>
<td>The recourse to “traditional” investors is preferable. Trusted VC funders with whom you have had a previous relationship… I have built a network of contacts since in 1989 I co-founded and was COO of GGG, a company listed on the stock exchange starting in 1996 (Nasdaq and Paris).</td>
<td>... when we talk about VC we talk about a lot of different specialists, anyway, some of them will have the specific knowledge about… or certainly the contacts to be able to find the right set of technology, to make a good assessment.</td>
<td>My network is actually quite academic as well… so the universities’ Technology Transfer Office… usually comes through to me that way.</td>
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<td>... I can’t recall being approached by anybody who wanted to put money in, we had to go and seek it.</td>
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<td>Now they [firms looking for money] go directly to funds, probably also because the regional funds have been around for enough time (about ten years) so that people are now familiar with them.</td>
<td>They’re successful because they trade their portfolio successfully so when they get this network based on the fact that “I might be an investment guy in a particular company, I’ve got this investment here, I’m looking to exit it, and I’ve got guys in the M and A groups… who are I previously worked with… I wouldn’t say it becomes a self-fulfilling circle, but it certainly helps.”</td>
<td>... further opportunities are spotted in participation in spaces such as the Youth YES Programme, technology transfer at European Universities (ESTP) and every programme where I am invited to teach. Interestingly enough, no referrals are made by banks, intermediaries, patent agents or lawyers. Additional contacts are available on the basis of my prior experience with other funds, and universities and companies related to my earlier professional career.</td>
<td>... Into the other universities, we have a different relationship; we don’t have the one-one technology transfer relationship, we don’t have any formal relationship with any other university but with IC. With everybody else we are out there, we talk with their TTO, we talk to their academics directly, we try to get a feel for who’s hot and who’s doing hot new things… and then we sort of try and tag ourselves a long way back with that group of people, with that research group to see whether that is something that we can ultimately shape as a spinout.</td>
<td>... we have a NS geographic area [beyond Denmark], which is the Nordic region, so Scandinavia, Finland Iceland, so we’ve been present at sort of local meetings and that is the main source of deals we get… are from being known either in exposure through those kind of things or actually through our own network.</td>
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<td>... A final source of deal flow is the more established firm management you have worked for. Some are able to do even as many as 100 transactions a year. That allows them to make a lot of networking with the non-executive directors’ community, former investees and the like. Also, in the bio-tech sector, I undertook an investment in a stem cells company that extracted and stored stem cells from baby</td>
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teeth because a person I knew, R. Archer (from GG), went onto the government committee of that company.

the same need for money and many of those that come to you have already created a previous relationship with you ("a selective set of deal flow") and that's probably more than they have to worry about in terms of deal flow.

The usual networking and business finding mechanism for dedicated funds includes attending and partnering conferences in the sector or visiting universities to scout for projects so to "bias what sort of deal flow you get" so you build up your network of contacts. A reason for generalist funds avoiding this strategy has to do with time and money costs.

So it's all credentials, it's all networking... consultants, ex-portfolio executives, non-execs... There is a lot of recycling for non-execs. Non-execs are a great source of deal flow because... they might have a portfolio of six or eight companies...

strong network of people around the UK particularly and, given that II is an active investor in life sciences, we do tend to find that a combination of strong networks and a tie to invest that makes a lot of people do approach us with interesting ideas...

I14  
We've met with some business angels... We have been open to sort of... it is an opportunity, absolutely. Pharmaceutical development is an expensive sort of venture and a business angel will typically only help you so far... you will not get to the market with a business angel. So that may be extended only a short term... fixed... to get to a new value inflection point. But, with the right people and sort of with the right attitude to the project would come by, we would be interested in that, absolutely, why not.

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... I think the networking is important. Because of how we work, the cold contact is not open... we do not do many investments through cold contact, but that is our model if you like. I know of other people who almost exclusively just wait for business plans to be submitted to them.

... we were to provide them with some... (sic) you know, a couple of days, a month or something like that and then get them to use their networks to go out and find something that they potentially wanted to get involved in and then bring it back to us, you know, to... to pitch the deal into us.

We don’t directly approach individual researchers, but what we do do, we work with the community as a whole, depending on the sector, and we have different mechanisms for supporting.

... it [deal flow origin] is a broad mix... But normally what happens is that an opportunity is identified by an entrepreneur which may be an opportunity which is coming from academia, research institutes, and that entrepreneur brings us the deal. So it is not common for a university to call us up and say 'we have this great idea' with everyone to spin out the company because the university is not very good at doing that sort of thing...
We [also] have a strong, a regular relationship with CBX and... I think many of the projects that are incubated there actually apply for grants in our programme.

... and, you know, the potential purchasers of our investment... companies. So that is another important network, there are others... I am sure there others, as well as, of course, general networks of lawyers and accountants and people who provide important services for our businesses...

Another third [share of deal flow] comes from advisors, and again that is a change because with early stage deal it is less usual for companies to have advisors appointed because they are expensive and, obviously, they... they tend to only get involved in companies usually raising more meaningful amounts of money and...

... so we had to invest quite a lot of time in getting to know that advisory community, making sure that we are on their list so they know what sort of deals we like and to make sure that we get a few of those.

I was working enough to head up CHS for eight years and, I think, a probably did... well, I know, I kept track of 1,500 individual investor presentations. And that is what you have to do to get people to know you.

... there have been a few people, there are investors who ??? and say ‘Hey, I understand you have a new company right now, you know, when you come to New York, come and see me’ but, you know, that may happen every now and then... but most of the time it is the... it is the company that wants the investment reaching out to the investors.

... I think that, in some cases, it is some of the smaller firms, you know, firms that manage less than a hundred million or less than fifty million dollars... or just manage their own money, they have had to come out and reach out to companies that they like and say, you know, ‘would you come and see me? I am taking that investment in your firm.’ But most of the kind of blue chip industrials that you... that you really want to be involved with, you know... manage, you know, five hundred million after probably firms match, you know, greater than ten billion dollars. You are reaching out to that, you are chasing them down, you are trying to get into their office.

I think venture firms probably do more that because venture firms have got... look at
finding assets instead of companies' work, perhaps venture funds... if they think somebody is doing a very interesting work and perhaps is ready to go into, you know, some pre-clinical phase... and, you know, they think it is novel, I can see them are reaching out to the possessors and saying 'you know, we'd like to license your asset and then sort it out with the management team and then, you know, put it out there and trying to get funding.'

Source: Author's own elaboration
 Universities… also have seed-funding capacity and they contact regional funding investors for rounds B and C, later, to look for co-investors. … people like me always try to widen the network within the corporate finance community and the universities. So private equity practitioners will always be looking to go out direct. Probably not direct to the companies, but to their advisors and institutions around companies, places like incubators and such.

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<td>… so they [specialised investors] intimately understand it and they do know their peers and they have got a great network and that would be part of what differentiates it. This is the value they can add.</td>
<td>… we are also investing in companies that have already been established as long as they have good connection into the university. There, I guess, we draw more heavily on our network of other contacts; so our network of other contacts might well be other venture capital firms that have invested in them, angels or other people within our network we are respect and known very well, who want to bring us into deals or management teams that we have worked with before who are looking at starting something up that meets our requirements. … and there has always been reasonable people to invest alongside and work with, so I think we are well placed to see quite a lot of things happen in the market at the moment.</td>
<td>[our network is huge] … I think that is, actually, the fundamental of success. You know, new funds find it very difficult.</td>
<td>I think they are happy to actually build a syndicate, so that is the way that most… I don’t know… projects should be driven. First of all, it is nice for the people who drive the projects that you have a syndicate because then you have, of course, also then a balance to talk with different investors. And, of course, it is also nice for the investors that … [that there are] more than one just to drive the project.</td>
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<td>… I was talking about these partnerships and networks; there is a lot of European funding for these networks which is an excellent way of pooling resources and leverage. So they have become increasingly important.</td>
<td>Then we have a network of venture investors that we can reach out to, we have a network of pharma executives, ex-pharma executives, you know… and commercially-oriented people that can evaluate the opportunity… we have our network from our past research history.</td>
<td>… because what we do is we don’t invest alone, we invest hopefully in syndication with others to, you know, mitigate the risk and to validate the propositions; so, you know, someone else wants to also invest, you feel more comfortable that you are not doing something weird…</td>
<td>And our deal flow came through our co-investors, so other firms that we syndicate with, it came through our non-executive director network and chief executive network and just about anyone in the industry we are in…</td>
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<td>… so we would get people to be venture partners who had experience into medical devices where we hadn’t done so much… you know, working, active investments at all; somebody with a track record who can… knew where they were already… Well, I’d say networking, but also contractual obligations… you know, signing people up to provide you a particular insight. So that is people like venture partners, also getting entrepreneurs in residence, somebody who’s got a</td>
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**Table 13 - Networks – excerpts from interviews (c)**
particular expertise…

you know free and willing into an area where we wanted to be… where we may have identified an opportunity and then brought somebody in who’d got a track record on…

… I remember our best event, I think, it was doing a wine tasting event which was actually… actually other VCs stated it as well, trying to get you together… get together within a social environment. So, it doesn’t happen very much, but it actually does… it does help because what you are kind of trying to do understand the strategy of the other firms, you know….

… you want to know about the business that you are investing into, but you also want to know about your co-investors because if they back out, it’s going to leave you with a problem which is a company that you can’t fund and that is going to adversely, potentially, affect your value. So… I mean, I think a lot of it is about personal relationships as well as understanding strategies.

… what also happens is that, you know, there is a big conference… same in terms of people, going to conferences to hear companies pitching but you are also using that as a basis for catching up with other co-investors and talking about problems that you’ve got and looking to syndicate new deals, et cetera.

Source: Author’s own elaboration
If they [entrepreneurs] are unknown, if they’re starting afresh, it’s quite tricky to start with; you need an angel if you like, you need a mentor, you need someone to get long sight who’s got the industry reputation to make it happen for you, because without that it’s very difficult to get off the ground. You have to be working with somebody…

AAA was already operating in fields where ABC needed to move, so they were already established players and that makes market entry much easier, that was the major reason. In terms of science, the reason very clear; they had expertise that we do not have in the manufacturing of instruments, and we had expertise that they needed…

In terms of looking for deal flow, there are different perspectives depending on the type of fund. For example, purely dedicated life sciences funds (e.g., PanEuropean funded university spin-out fund called Merlin, I I have worked for) are different from generalist funds (e.g., EV). II, for instance, was heavily tied to the college activity and they had a network set up for that purpose. The university spin-out fund, on its side, tended to be more pro-active than reactive in the search for deals…

Generalist funds, on their side, are almost averse to wanting to see bio-therapeutics-type opportunities because the capital requirements and the time to exit are so long that it is not really a sensible place for those sorts of funds to invest. Consequently, they do not actively hunt for deals in this industry, although they can be approached by some companies.

Funds that have decided not to do bio-therapeutics spend less time maintaining that sort of a network. If all you are doing is life sciences, it is much easier to have a

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<th>INTERVIEWEES</th>
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<td><strong>If they [entrepreneurs] are unknown, if they’re starting afresh, it’s quite tricky to start with; you need an angel if you like, you need a mentor, you need someone to get long sight who’s got the industry reputation to make it happen for you, because without that it’s very difficult to get off the ground. You have to be working with somebody…</strong></td>
<td><strong>AAA was already operating in fields where ABC needed to move, so they were already established players and that makes market entry much easier, that was the major reason. In terms of science, the reason very clear; they had expertise that we do not have in the manufacturing of instruments, and we had expertise that they needed…</strong></td>
<td><strong>In terms of looking for deal flow, there are different perspectives depending on the type of fund. For example, purely dedicated life sciences funds (e.g., PanEuropean funded university spin-out fund called Merlin, I I have worked for) are different from generalist funds (e.g., EV). II, for instance, was heavily tied to the college activity and they had a network set up for that purpose. The university spin-out fund, on its side, tended to be more pro-active than reactive in the search for deals…</strong></td>
<td><strong>Generalist funds, on their side, are almost averse to wanting to see bio-therapeutics-type opportunities because the capital requirements and the time to exit are so long that it is not really a sensible place for those sorts of funds to invest. Consequently, they do not actively hunt for deals in this industry, although they can be approached by some companies. Funds that have decided not to do bio-therapeutics spend less time maintaining that sort of a network. If all you are doing is life sciences, it is much easier to have a</strong></td>
<td><strong>So it is the network, being visible in the area, and then, of course, the most pre-seed grants and seed investments we do, people know about them and see what we are doing and learn about us that way. We do a little scouting and that is typically in the form of… we’ve been sitting down for instance selecting an area of given diseases and looking at who’ve done interesting publications in that area and we try to contact them. But maybe in two or three of our portfolio companies you can trace some origin to that scouting, but also that is not something that we pursue a lot and simply we don’t have much time for that.</strong></td>
<td><strong>… we do spend time building relationships with a whole variety of players in the sector, it might be pharmaceutical companies that are trying to spin out, a set of small companies, we spend a lot of time networking with the funding agencies like the NRC, the WT, we are well connected with the entrepreneurs in general, and because we are such a big fund and so well-known globally, pretty much anybody who is looking for money comes to us. … we have good working relationships with many of the academic institutions, and we think that is enough. [but] We don’t think we need to do those sorts of deals with universities because you are limiting your own horizons if you do that.</strong></td>
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The investors and our advisor board have been particularly helpful in giving us some challenges and feedback and... We have seen the process a lot of times; they know... sort of they have an idea on where the problems can arise and they have asked us questions and prompted us to investigate things further, so we've done that.

... I think, of course it depends on who the business angel is. And I don't see a huge problem in a business angel not being completely knowledgeable about the field. They can add value in other ways than scientifically validating a project. A lot of business angels have sort of managerial or strategic skills which could supersede those skills represented in any venture fund.

So we do have a level of sector expertise within our own team. And we do bring in outside experts for those opportunities... we don't do all kind of work though, sometimes when we do lay things to be outsourced... due diligence, we do the due diligence ourselves, but we do rely on our network of experts... and because, I mean, our portfolio in all is about eighty companies, which... every time some brand new company is... each time you have an employee to... you know, companies like BBB which are 150 employees and are worth hundreds of millions... so, through that portfolio we have a lot of very sector-specific expertise that we call on. And we also have a... which I think we are unique in the venture capital community... we are unique in our head hunting function... we use to source executive personnel from our portfolio companies as well as other sources, but from our portfolio companies and through that we have a strong networking through individuals who do have very big sector expertise.

I suppose part of it is also... one thing to... potentially pick up deal flow from them (other firms) so that they understand your strategy and they know what you might actually be up for. ... we basically we draw upon the last network of our own, but also our system for new ventures... it is a group of funds that have presence in the UK, Denmark and San Francisco, and we reach out to that network as well... of industry experts, and consultants, and CEOs, and regulatory advisors and whatever.

... we have a pretty good network of serial entrepreneurs that we can, you know, draw upon for a particular project. Many of our projects are small and virtual, so the same person can maybe... be responsible for... or work in two or three projects at the [same] time.

... one network could be all the key universities and their technology transfer departments, which is the gate-keepers to their technology; another group or network that we have to be involved in is the network of other investors, other funders, other sources of capital...

... another network you have to be involved with as an early stage venture capital fund... is a network of potential management talent, so that we do by mainly being close to the recruitment firms... the specialist recruitment firms who specialise in pulling people into small companies, they have themselves got huge pools of people on their resource...

And so, there is lots of these networks we have to have and so, you know, we will manage those networks, keep them current and not forget them... so it is quite of... again, that takes a lot of my time up, you know, just keeping everybody sort of comfortable.

... So, I mean that is two thirds of our deal flow come in from advisors and ACP originated; the rest, most of the rest, is truly direct approaches from companies and then I squeeze maybe five percent is other investors or other non-execs and chief execs through their

It would be rather easier for small biotechs who hire someone who has already done it, you know, gone through networks, investors, investor firms, bankers, analysts, you know, fund managers, rather than to start from scratch from somebody who is not I was introduced actually to someone in a venture capital firm. But in terms of kind of this network of people who have succeeded before, it was not really quite my story.
networks. known to anybody, who does not have the reputation…

… a lot of this is relationships, a lot of this is what have you done for me in the past, you know, did I do well with your company… if I did well with your company, I am much more likely to invest in your new company than I would if I did not do well with your previous company.

Source: Author’s own elaboration
Table 16 - Interactions – excerpts from interviews

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<td>... so we chased around and I knew a few of them anyway from the previous life and I’d been involved putting a company on AIM... so we went around and it is a painful process because getting people who specialise in your size of company, early stage at that point, there are not many of them... so I suppose I was fortunate in knowing some of them and when I have advice on who the other ones might be.</td>
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<td>... because we were trying to raise money in a pretty difficult time, the world was about to fall about and there was a lot of reluctance to invest in what would be perceived as a very high risk sector... so we did have difficulty getting the money, we had not exhausted everything but we were beginning to wonder whether we would make it when we got the MVM money...</td>
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<td>... it takes a lot longer to develop a medical drug (on average ten to fifteen years) and is very expensive (over £1bn on average per drug). This makes choosing investments a very technical process and something that is best suited to professional investors. Investors will look at a whole range of things when making investment decisions.</td>
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<td>In terms of the team, that’s a basis for starting a team; so you’ve got your technical founder, they’re going to be the CTO, although they are probably not going to be the CEO because just can’t raise money off just like in software... you probably can raise money from a geek, a foreign geek; the answer is more from someone who’s out...</td>
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<td>Also, because of the profile built by regional funds in the old days of public sector regional development agencies, some opportunities came in directly that way. That has changed a lot, however, in the last nine years as corporate financiers are no longer originating the opportunities and linking the science with the markets and also demonstrating the feasibility of an idea. So I think very often people come in and just present all their data and show the use of working into this and the fact that nobody else checked it, but they don’t actually show the ability to get to the next step and to handle that bit of funding...</td>
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<td>Working with credible people, people who have a demonstrable checked record, is the best way to mitigate risk. You can mitigate risk by recognizing it, identifying it, understanding how you are going to manage it... [and] credibility, the plan, you can use experts to review that. But we tend to start with two things, what’s the...</td>
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who have invested in the business and, therefore, you've got to manage that collective group when you are looking to bring in further investment; so that is undoubtedly problematic.

I suppose they [potential investors] will have their own networks, you wouldn't see them kind of actively scanning the ground through rather different organisations and networks, and I think certainly the challenge for us in the North West is that a lot of that type of activity will be focused around London and the South East where you've got VC funds that are based in that area. The number of VC funds that we have up here in the North West is relatively small, certainly in the biopharmaceutical area.

These include (but are not limited to) the strength of the science, the possible market opportunity, the therapeutic area the product seeks to address and also the strength of the Intellectual Property.

There are many more variables than there are... or fewer variables with less control over them than in software. It's all based on competence, it is based on trust...

... most of life science investors know each other; they manoeuvre between investor capital, so... Lots of people would not syndicate because they do not play the game right... But essentially there is always a lead investor and then the co-investors, the lead investor essentially manages the deal and the co-investors just put the money. So, in terms of that, that mitigates a relationship for a lot of people at the table are saying different things for the same amount of sales, so that is that.

They tend to do on a contingent basis and, in an environment such as this, they don't want to take the risk of spending a lot of time and not raising money.

The trends in the biosciences industry, including the large capital requirements, have also pushed PanEuropean and global investors playing in the US and Europe to syndicate funding. So in the bio-pharmaceutical sector you can see both a competitive business where they try to beat their peers, but also a set of people that co-invest on a regular basis because they have to. So a lot of deal flow comes from the networking among investors.

... you can go to an investment committee and say ‘it's not me being mad, but these other lads are also being mad.' And what makes it even better is if you can bring along a co-investor who specialises in... if you are a generalist investor like me, if you can bring along a co-investor who knows what they are doing in the sector. The problem in the biotech world is all of the primarily biotech-focused investments... investors have not got a good track in the VCT (Venture Capital Trust) world or, if they’re from a more conventional structure, haven’t had the time to make it work.
Interaction between the fund and potential start-ups is much more intense under this programme since most “companies” do not have a full business plan, but just an idea. The relation with them starts with helping them to shape the idea into a business plan if the fund believes the idea is worthy and the people behind that idea are ready to be helped. Unlike most VC funds, SI invests more than 2 days with each “company” to develop the support process.

One of the reasons that we focus on the Golden Triangle is our policies are more keen about investing very early, so we believe that if we are going to invest very early, we need to be quite hands-on with those companies as we are forming them and then also as we have grown them through those early phases; and if we are going to be hands-on with those businesses, we need to be close to them—because it is very difficult to manage a very early stage business from a long way away.

We are predominantly reactive, although we do a little scouting. But, again I would point to our unique structure here, we have this pre-seed programme which is quite a unique thing, and of course a normal venture fund would not be able to have such a thing, because this is true grants… we give funds away, there are no strings attached, but we can do that because the foundation is a charitable trust giving money to basic research every year. So, actually one important source you can see is our pre-seed programme; we have two varieties of that, we have exploratory pre-seed grants which are given twice a year…

I think maybe it sounds a little bit arrogant, but I think we see close to 100% of new things in Denmark; I would be very surprised if any projects were not through our deals at some point in time.

We have offices in San Francisco, Boston, and London. So we will tend to invest anywhere in North America and anywhere in Europe. And we think that… by doing that, we’re always got one office that is close to the companies.

Almost by default you end up in those sort of made into clusters because that is where all the entrepreneurs are and where all the infrastructure like patent lawyers and finance people are all sort of based. However, we do invest outside of those areas.

… if you bring in small investors, you know, they have a different agenda. And it becomes very difficult to manage the syndicates. When we do bring in small investors, we make sure that they have no real say in what happens in the company.

First of all, of course, they need to like the idea and the team, as we talked about before; they need to understand that the plan laid out for this funding request that the project is having… is actually feasible and doable. So I think that is the first negotiation that is going on. What you are trying to show in

Well, actually when we had a meeting with one of the Danish ventures funds, the one fund that invests in seed capital… seed stage projects, beyond NNN, at a very early point in time and they said ‘alright, we are ready to do it, we are interested, we would like into more thorough

No, they are all over the place. So, I mean, if you look at our website and see where actually universities are, they are all over the place…

So we, we tend not to co-invest with business angels because they rarely can follow on and particularly in life

… building trust is something you only really do through talking… you know, face to face and it would probably be unthinkable to actually go straight into a new deal, you know, with somebody which is… actually, I’ve just been off a call with somebody else who talks about… it’s quite

In fact, we actually will help support groups of universities and research organisations to develop these partnerships as part of the European Frameworks and so on that are going on. They are hugely increasing in importance and we very much work with that trying to have an
the beginning is actually that you are prepared to actually have a dialogue with them. You need to actually be ready to answer and give feedback in a diligent way and... I think that is the first thing. So, what you do at the first meeting is you try to understand if you like each other; if you do, then you establish a dialogue and then you also still [wonder] ‘ok, can we actually work together after this potential investment?’ So it is more this dialogue that needs to actually be very smooth and you need to show also that you can make some decisions that might actually go against what they think is a good decision... So they are, of course, also testing you, if you are able to make some decisions.

We can invest... in Nordic countries, so that is Denmark, Norway, Sweden and Finland... and Iceland. [investing outside this geographic area], that is a different department. That is not NNN but MMM, which is... we are all part of NNF, which is the holding company, but we are different departments and our geography is basically the Nordic countries. And very, very, very early, MMM is more later stage, chemical stage you could say, it is a fund that invests globally.

We have... we have new people, we read papers and we think this is an exciting new discovery and invention and take contact to people (sic), we have this unique grant programme that actually reaches into investigation and due diligence.’ In all cases we approached them, at least initially, yeah... and I think that when you start with an idea and no results, it has to be that way because they will not be sitting and waiting, they will not be scouting for just ideas, they will be scouting for results. sciences. So, we do like co-investing simply because it means that, you know, if you look at a typical med-tech opportunity, you... it would not be unusual for your first round to be half a million and then another one and a half million pounds to get to see the market and then two or three millions for launch... we are not going to do that on our own and, then, by having co-investors we can come in early because I have the fire power to do all of those investments and give the companies security as well. We usually also lead, particularly in the earlier rounds...

Jolly, he talked about the ‘oh, shit! Board meeting’ which is the first board meeting where you turn up and you find what you really invested into.

I think it is definitely co-investment rather than competition because actually when you look at the number of companies seeking investment rather than at the sources of capital it is a very... very eschewed...

... and also investing together because you see the same class of share in a way, whereas if you go through different rounds of investing, you know, you might end up with A, B, C, D shares... you know, it is a nightmare because you have different preference rights and it gets very complicated.

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| We can invest... in Nordic countries, so that is Denmark, Norway, Sweden and Finland... and Iceland. [investing outside this geographic area], that is a different department. That is not NNN but MMM, which is... we are all part of NNF, which is the holding company, but we are different departments and our geography is basically the Nordic countries. And very, very, very early, MMM is more later stage, chemical stage you could say, it is a fund that invests globally. We have... we have new people, we read papers and we think this is an exciting new discovery and invention and take contact to people (sic), we have this unique grant programme that actually reaches into | You are more comfortable with co-investor with whom you have worked well in the past and you tend to find that co-investors do... are serial co-investors. So, for instance, we have three or four companies where we have got the same co-investors each time and we, you know, they... are the same individuals are sitting on the board. So, again, it is a right personal thing at the end of the day because this world of venture capital and academia as well, you know, you can abstract it all to the kind of these technologies and science, but for me actually, just as important if not more important than nuts and bolts, is the personal stuff because there is a lot of trust in boards when you are | We syndicate a lot less today than we did ten... five to ten years ago. And the main reason initially was actually just the sort of shake out in the market. And where we were involved in heavily syndicated deals, we started to have to deal with the challenge of having co-investors who no longer had any funds available to invest... That is not a great place to be because then the funding... the future funding requirements for business end up falling on us because our co-investors are not able to kind of keep up. So... so, I guess, inevitably our number of co-investors had to be shrank dramatically because the number of investors in the market had shrank; and it is our preference to co-invest with other | Yeah, it is more usual to have co-investment, even today, that's for sure. Why is that? Because... you never know when companies will need more money and it is always better to have deeper pockets to be able to overcome the ups and downs of a project successes and failures... and these days, sometimes you need to fund companies into the future rather than just the near turn. ... you know, obviously companies, venture companies have people to do that [due diligence and other related stuff], that is really critical. You know, it is a really key... key role. | We like to lead and we have a group of other firms that are willing to look at early stage deals that... you know, we have worked with before that we invite to look at deals we are leading. And, you know, that has not been a problem to find... other folks to invest although it is one where, you know, you need to build relationships and track records for that sort of thing because there is not that much early stage money around... but, there is some. It is probably neither easy nor difficult in the sense that is something that you work out... I mean, it is... you... we are in this business because we think we are smart, opinionated, knowledgeable people; we are often that... and so... you
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<td>126</td>
<td>Hmm, I think that it probably would not have been something we suggested, we did not really care. But if we wanted to raise twenty five million dollars, it sometimes was only possible to do that for, say, three investors as opposed to one investor. I suppose it was just impossible to get twenty five million dollars from a single person.</td>
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<td>Yeah, the lead... the lead investor in any deal is going to be responsible for the bulk of the technical due diligence. They will be hiring outside experts as consultants to review all aspects of the deal including, you know, doing diligence background checks on the management team if they are not known, doing diligence background checks on the molecule, the intellectual property... you know... prior data... so it is... typically takes months, you know, to come to an investment decision.</td>
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<td>I mean... you know the reputation of most of the funds. And you know whether they traditionally hold long or not. Those, again, are the ideal investors, especially if they are a very big fund because either in the situation of whereby a fund has held like a ... maybe 50 percent of CHL, but that holding of CHL was like point zero ... zero one percent of their overall holding, and so they don’t even think about you until you come to New York, you know, once every six months, and say 'Hey, you want to see' and they say ‘OK, I’ll come and buy up there.’</td>
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<td>129</td>
<td>Hmm, because it is hard... and so, you know, we do that. It is... it is just a part of the job and I think the relationships we’ve built and the track record we’ve built says that we’ve been able to do that part of the job very well.</td>
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<td>We... we engaged a bank... we worked with The DB to do the fund raising for us and I think they took about six percent of the money or something of that nature, which is a fairly standard sum. We already had a lot of contacts with the analyst that we were... I did not even know that you can do that in the States because of all the changes on the ??, actually. And when we were looking for it, we interviewed a lot of different banks and we went with the analyst, who seemed to know... actually know most about the space. You know, the guy with the most technical knowledge,</td>
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investors because it makes for a complicated capitalisation chart… you know, any kind of issues around the company that requires a shareholder vote; it gets really complicated if you have to track down a bunch of angel investors and get all of them to sign up on something. So it is just quite cumbersome if you have a bunch of angel investors involved in an early deal. So those can be red early flags for a VC, not necessarily deal killers but just something that makes the deal more complicated. And if… you know, all things being equal, if you have once company that has a corporate investor with angel investments and in another one everything is equal, that is a kind of a clean cap table… the VC would prefer to go towards the latter.

Well, my experiences is there is a kind of bio-tech mafia in the United States. And, once you get some groups interested, they have a lot of their colleagues, or friends, or people they like investing with. They will specifically ask you to go talk to some of the people they like investing with and so they'll call you: ‘you know, you should go and see so and so and so in this trip. And if you are going to Boston, why don’t you go see so and so, give them a call and tell them to make some room for you.’ I mean, this is like anything else, you know, there are people that have invested with each other over the years, they are friends, they have got relationships, they have got other people that they really respect, you know, for their abilities at due diligence.

Source: Author’s own elaboration
Table 17 – Availability of funding – excerpts from interviews

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... I don’t know that he put any money into it actually, which is disappointing in my view, but then we went into angels and grants, or grants and then angels, so the natural thing for us at that point in time (I’ll come on to what the government are doing at the moment, which I think... the last government did some useful things and these people carried on, gathered some courage and carried on... I think they are making very positive steps and providing alternatives to the VC model), but the VC is still... when we invested in 2005-2007 that was the natural thing you would do... I think the people in the government are interested in the space and they work hard in conjunction with the biotech industry association and the association of the British pharmaceutical industry... I think they work hard to try and get a bit of financial support, recognising that it is very difficult for start-up companies... And the BIA has anyway come up with something called the citizens’ innovation fund whereby... you are aware of BIA’s relief and VCT relief, so BIA is gone up to 30%... the BIA are keen to introduce the citizens’ innovation fund which is basically encouraging small people, not just wealthy angels with a million quid to spare or even people who might invest 25 to 50 thousand but actually coming down to about 15 thousand... Generally, I tend towards now moving most of my investment towards institutions; so the big institutions, the pension funds, the big fund managers in London who are prepared to invest in companies that are growing quickly, highly innovative and in our sector, so they know they are going to enjoy a good return. Again, specialised versus non specialised investors, that carries with it a degree of know-how, understanding of the sector, a great deal of know-how and understanding of the business... ... in theory, all of these [sources] can provide funding, but very few of them would without a track record, an understanding of the management team, a clear business plan, the right return... First of all, it’s difficult to float a company. It’s almost impossible. One in a hundred companies would without a track record, an understanding of the management team, a clear business plan, the right return... ... the risk model for what we do is not a model that the bank would lend to. Until you’re generating high bottom line profit and there is a sensible return on that business model, a bank is rarely going to take the risk of giving you any loan position. ... the funding that AAA used to purchase ABC was from a VC company that was already funding ABC, so it was there to put money into the company rather than de-risking their investment because they were putting money into an established player that was already generating revenue to fund the work that ABC wanted to fund, anyway. It’s relatively easy to get money from grant funding, but there’s uncertainty and there are... will the government fund me or not is a big question... the uncertainty is the problem. The second problem is the time that it takes... ... we had investment from Cancer Research UK in a drug development project... it was low quality in terms of the amount of money that they gave us, it was very close to barely enough, it was barely enough to do the project; it was high quality in the sense that we had an investment manager from them who made sure that we kept the milestones and the deadlines, which as an academic you don’t usually care about... ... the banks are too expensive and they would probably not fund us because we would not be seen as a safe enough investment for them; we do not generate a revenue, we do not make a profit, so I think they will see us as a high risk... Funds have been obtained essentially from different government programmes and sources. Also, you might eventually think of customers as shareholders... Many of them may be interested in a good investment with a known company. ... At the time [late nineties], I succeeded in raising over 20 million Euro for these two companies [co-founded by me] directly, through various venture capital firms as well as public agencies. IPOs are not a good option today... the market is simply not there! ... acquisitions or even joint ventures may be the way to raise the money you need. ... In 2012 the company receives further support under the form of an R&D grant supplied by the government. I think it really depends on the specific company or organisation and the kind of... their comfort with the different funding opportunities and the technology that they’re working with. I suppose, companies, the majority of small companies are very focused on the TSP at the moment and see what they can get to offer from that. There seems to me to be sort of an unconditional confidence in IPO, which I don’t know if it is a good thing or not. Our personal experience of AIM was that it was a very hard place to be when you are an early stage technology company... is being a listed company the right thing to do when your early technology is so tentative and precious... For small companies VC funding is still very important and that’s kind of a significant bit to enable people to take the next step forward and to get down the path. If you are a university company spinning out or a start-up, then obviously it is a vital component of the finance market. ... there was a lot of regional support that kind of bolstered and gave some confidence to the VC’s coming in and put their money in. Obviously, that has changed over the past few years and the VC money particularly in biopharma has vanished.

The other companies...
… Now, it does create problems... because if it works and people do show interest in that, you might end up with 500 shareholders, which is not very healthy as companies... you get into the dilution problem for the original investors and they end being soured by the experience...

… so to say that somebody who has made his millions out of property is an angel and wants to invest, why would he have a go in this genotoxicity project... he would say ‘I don’t understand that, therefore I am not investing’...

This is changing with a greater mix of funding now available as the traditional source of Venture Capital has become harder to come by. There are now a reduced number of VCs investing in life sciences and bioscience in particular (although this may be picking up), and these VCs tend to be specialist investors rather than generalists. Bioscience companies now look to a wider range of funding opportunities to support their business. These include medical research charities, Corporate Venture Capital arms (equity investment arms of large biopharmaceutical companies) and government grants.

In terms of the public money, I am a very big fan of public money in bio-pharma because otherwise there wouldn’t be anything yet funded. Right now I have two bio-pharma deals with public money that are now going into raising significant amounts of money and that... if they had not raised the public money, they would still be out there raising money. And I think the way to do that is to have focused funds on... it is not to have generalist funds, but to have focused funds where the investors understand the technologies quite intimately, where the investors are incentivised to put money out...

… therefore the public money is valuable... and not in healthcare specialists had backed away from that and would just put their money into medical technologies.

… typically, angel investors are not going to put in the volume of money that is needed for pharma and bio-pharma. The projects I’ve seen angel investment on have been medical technologies and things relating to maybe medical education and that kind of... so healthcare related, but perhaps not sort of the high tech stuff.

[Banks are not ready to give money to innovative projects]... not to crazy ideas, but perhaps if there was an opportunity for expanding into a new market or doing something relatively low risk, that’s where in my experience banks come in.

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<td>... in the biopharmaceutical area they will be looking for various forms of grant funding, and seemingly companies either are getting that through going to be organisations like the Technology Strategy Board... so, they are not going to get that through banks and they are not going to get that through angel networks, so they'll be looking at a variety of options of which venture capital will be one element. From our experience, the banks won’t be investing in these types of businesses, so you end up with two solutions: either you’re fortunate enough to find an Angel who wants to invest in this type of business, but that is quite a challenge in this particular sector just because of the</td>
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<td>This can be quite an issue because the management are continually fund-raising rather than managing the business. This may also reflect the fact that there is not that much early-stage funding in the UK market. What funding there is, it is primarily business angel or small university funds and it’s a bit like herding cats. Because there is such a big diversity of funding sources in the beginning, it makes it difficult when institutions get involved because you have to take account of the multitude of shareholders.</td>
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<td>No two VCs are alike and, for example, early stage means different things to different people even if there are statistics that say that it is going to be the same across the sector... there’s not many generalist players; and there are a few larger dedicated life science players, but they’re investing in the best opportunities across the globe or across Europe. The corporates have played a bigger role in investing in early stage, to they’ve definitely moved downstream from simply wanting to pick up late stage clinical programmes; they’ve been involved in lot of the earlier syndicates and continue to support early stage companies. That’s...</td>
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<p>| time scales and the risk associated with that; your other two options is actually the management team of the business put in their own money or you’re looking at sources of government-funded grants. It's a classic that for those people that have got the connections and the track record of developing and exiting businesses successfully, they'll be able to attract that investment [angel financing] reasonably easy. For people who try that as first time entrepreneurs, it's much harder. | the form of grants because people view grants as an alternative to have equity investment and the grant starts with an evaluation of business, they don’t support the management behind the business… it is a soft landing, so the public money is a soft landing, and it is a cushion before you drop out when you are getting big time into the biotech… … the VCs are actually quite happy to have some private capital behind it and the people who are funding this with private capital are happy to go in because the VCs are there because it gives them… they don't have such deep pockets... they don't have such a funding risk on them... but also those angels, if you want to call that the private investors, are very, very high risk-oriented individuals, who are all very experienced in putting a lot of money at the door for tax reasons and sorts of investment… I have not seen generalist funds do pharma and I think a company who did tend this generalist fund, a pharma company who would tend this fund is probably a bit silly because they just don’t see the pitfalls; you want someone across the other side of the table to say ‘this clinical trial is not structured the way everyone wants it to be structured; you’ve seen this in another company and it did not work.’ … in biotech there is very few angels because people do not recycle that money; it is different in the US, they do that but over here [in the UK] it is | positive. And the other one is the government. |</p>
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<td>... Because we operate at quite early stage, we do see and we do encourage our companies to apply for grants and for funding that might be available to them by other sources...</td>
<td>I think, unfortunately, in early stage life science, it is hard to make the projects survive without some kind of government support. So, I think on a European level there could be some knowledge sharing [about State funding systems]... and again, I would be cautious though because it is not good for an industry to be very dependent on government support.</td>
<td>... there is a history of success in the States on IPOs. AIM is much smaller, more recent, and in recent times there have been some major disasters in English biotech companies. ... the problem there is that there are just not the investors around to get sufficient cash and when you are public, you know, you are always fighting the investors about the progress that companies are making. And because it is not a very sophisticated market, I think companies struggle on AIM.</td>
<td>... biotech companies that use something like AIM, they are usually going there because they have had a hard time finding any other financing. At least at the price they are interested in. And, as a consequence, they tend to be too small and they don’t tend to be so liquid. ... it is truly... that in the UK as a European investor that is actually favourable for us right now. If we had people in the US, I would prefer to do it in the US because their tax scheme is turning better.</td>
<td>I have been involved in several projects where we have government money and also EU grants. I think it is a great way of raising money for developing companies. I think they [corporate venture funds] are very active nowadays and they see the need actually to go into this type of projects because their own R&amp;D departments are smaller and smaller, some of them [are] even getting closed, so they need actually to be very active...</td>
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| Actually, we started earlier... actually at the pre-seed programme, so it is a grant that we received from them. So actually there are no strings attached, which is very lucrative... [Then] that is the AAA technology foundation which is a public... which subsidised a grant opportunity that high tech projects here in Denmark can apply for... and it must be collaborations between private companies and public research institutions. The private investments that we have is from our own sort of investment. We are a venture capital company listed on the XXX and we specialise in early space technology and particularly technologies that come out of the universities, so the way our model works is that we have a relationship... formal relationships through partnership agreements with a number of universities around the UK... Most of our investments go through the universities we have levels of exclusive access to their IP. There are quite a lot of... well, not that many funds that do early stage investing. I suppose the reason for doing that is that if you are going to fund something really disruptive then you kind of want to be the first to get it because you get the most of the value. So we go... we, across Scandinavia we have a pretty good reputation of being a very reputable investor, so a lot of people contact us directly; we also read scientific papers and try to identify opportunities, go out and give talks at universities, tech transfer offices, and so forth. And then, we have a special programme here at NNN, it is a grant programme basically, that reaches into universities where professors and principal investigators can apply for grants and... Well, two things at least come to mind. One is that this shortage of capital to invest in the early stage, especially the very early stage area... so actually if you are a fund just like ours, we get approached a lot, we get approached in an unsolicited manner; in other words, people come to us because they hear we’ve got, potentially we’ve got some money... people come to us, so that is one thing. The second thing is, and I’ll turn to that point, because of the number of good quality academic institutions in this country, which is where we tend to get out our deal flow,
private investment... we have put into the company our own money, both Prof. XXX and I, we have put in smaller amounts, not big amounts, but smaller amounts to get things going, and get the first test results and so on.

... we have some of our advisors are recognised in the Boston area, and we had good access to investors there, but for them to make an investment, they will discuss the project with you, but to make an actual investment, you need to move there, you need to have some presence... an office, people there.

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| I would suggest that over the last five to ten years the actual amount of venture capital funds available to new companies have diminished, you know, have reduced. There’s been a change in the mix of available funds, and what I mean by that is that there’s been an increase in the amount of money coming from corporate venture capital funds...
| ... there is kind of a whole range of it, but... you know... let me just contrast two different types of venture capitalists... there are a lot of different types, but in bio-tech some people are very anxious to invest only in late stage drug development; they want products that are in late stage clinical trials, they are often investing in, you know, c, d, e, f, g, h, j rounds and their deal flow, you know, is sort of... inevitably comes from other venture capitalists, from entrepreneurs that are trying to do another round of funding for an existing company. We are at the other end of the spectrum; we do a little bit of that, and so we’ve been successful with late stage companies, but I think that our special niche is with early companies...
| Well, there are three sources. One is angel investors who are sort of highly networked individuals who either alone or in conjunction with a larger group will fund a... early stage companies. Typically these groups do not invest very heavily in pharmaceuticals because it is so capital intensive and individual investors typically can’t keep up their pro rata share of the company when multiple rounds of financing are necessary to fund clinical trials. ... Typically the angel investors like to invest in companies that have a prospect of near to (?) revenues. Another source are grants... in the US there is the SBIR programme, that is the Small Business Innovative Research programme and they are widely involved in companies, including TT, that have successful... successfully acquired grant funding. Hmmm... [it is] very difficult to operate a...
| ... when I first went into... ran a small bio-tech in 2004, using the market for raising money was pretty good at that time. And I would say it was pretty good from 2004 down to about 2009. You know, around that time I raised 250 million for CHL and that was, you know, with Venture Capitalists so... yeah there were a lot of funds.
| From two million to twenty million, I think, venture capital is really disappointing. The only place to get it for a company that does not have revenues... You know, less than that you can get it from angel investing and then more than that, you actually go to other financing, like public financing. Government money... you know, this is really a... something I know a little bit less about than maybe others do. I know there are some possibilities to get small business loans, but my impression is the amount really is not great enough to really fund a pharmaceutical company.

I think... now it is well accepted... this [corporate venture capital] is a... mid way for companies to raise money. I mean, when these venture funds were established, people were a little sceptical that it was pharma companies getting access to technology at a very early stage, but I think as time has gone on, this source of capital has become more and more recognised, accepted, and welcome eventually.

I think the...
government is recognizing through both the grants awards and the R&D tax credit system, which is a facilitator for small companies to get extra capital, those companies that are engaged with R&D specifically, I think it is an important part…

company on these grants; there’s two phases to those grants: phase one is typically very small in the order of five hundred thousand to seven and fifty thousand and that is enough to do a proof of concept; if you are successful with that, you can apply for a phase two, that can be up to three million dollars… And, of course, the traditional approach is the use of venture capital money… and there you really have to have a strong network and…

are not dealing with the big banks, you are dealing relatively with the small banks. And, you know, there is a large… groups of relatively small banks which historically, you know, served the bio-tech industry.

Source: Author’s own elaboration
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<td>if a VC investor is a 3 to 5, 5 to 7 year investor, then inevitably they’ll try and usually put in enough funding for maybe a couple of years. Maybe not more than that. And if somebody hits the milestones, then, to some extent it’s likely that the follow-on investment will come. But generally, what will also come with that is the ability for the VC, if it is a VC, to position itself to see whether it takes a higher proportion of the company. So whether there is an up round or down round depends upon the quality of the company, how well it’s done, and whether the VC is prepared to actually then invest behind it. So there’s a lot of mechanics to some extent and strategy around the way in which each funding, each investor decides to position themselves. So, if we [the project owner] have good news, if things are going well in the company, then there’s a lot of interest, so I’ll say ‘it’s a good time to raise the money.’ In six months from now, who knows? It may be more difficult and I would say ‘I wish I had raised the money back, six or eight months ago.’ The timing is a big part of getting that right. Because it’s likely to be a natural part of the strategy to realise the profits on their investment, then they would probably like to be quite hands-on. If the ability to get profit on their investment will be dependent on whether they sell out the business at the appropriate time, to the appropriate party, they are likely to be very heavily involved in that part of the process.</td>
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| … investors often want to invest in biotech, in syndicates, and there is one deal until you get a part for probably 7 or 8 months. I started out as one syndicate of 4 investors and then needed another investor who had a part for developing some medical device… very attractive, very attractive company; then, we got this investor and he said ‘yeah, I’ll do it, but I don’t want these four.’ So, OK, fine. What do you do? You’ve got the same amount of each side of the table and you’re bringing someone else, so we brought someone else and he said: ‘OK, I’ll do the whole thing on my own.’ So it changes, you’ve done the due diligence for 4 people, you like this one person, but they can only do half… so there is all these different combinations of deals… So, as you get through down the line, as the businesses become more growth stage, so something in the middle of phase II trials, trials might out and probably really change it; if it is all going well, your team is already there, it is just simply a matter of cash, it is a three or four months deal. At that point as well, the quantum of the deal is larger, so ironically the smaller the deal, the longer it takes to get done because of the deal stage. But as we get further in the line, it takes shorter and shorter time and there are also more investors in the market. The problem might be that if there is a VC investor has a 3 to 5, 5 to 7 year horizon, the timing is essential for funds. The funds need to work for usually invest for five years before exit, which for bio-tech is the wrong model. Now, as for venture capital trusts (VCTs) (a tax-efficient vehicle open to the general public usually managed by commercial operators), they probably embody the best model to invest in bio-tech. They raise money from the general public, they have tax advantages, and they destine their moneys to SMEs. The biggest advantage is that the investment horizon is not limited to the artificial 5-year term that many VCs usually enforce. GG is a good example of how it operates and the advantages this type of vehicle conveys. In fact, regional funds face a restriction under the 5-year horizon because to a certain extent, that will force you into late stage opportunities. Opportunities in the pharmaceutical sector just take too long. A famous time line on how long it takes to go through stages 1, 2, 3 and trials in this sub-sector is about 12 years and an unknown amount of billions before you get to the market. That is not conducive to the private equity model. And then the exit point will probably be when the clinical trials are OK so you can raise money in the US market or through licensing. Licensing for small companies and usually put in enough funding for maybe a couple of years. Maybe not more than that. And if somebody hits the milestones, then, to some extent it’s likely that the follow-on investment will come. But generally, what will also come with that is the ability for the VC, if it is a VC, to position itself to see whether it takes a higher proportion of the company. So whether there is an up round or down round depends upon the quality of the company, how well it’s done, and whether the VC is prepared to actually then invest behind it. So there’s a lot of mechanics to some extent and strategy around the way in which each funding, each investor decides to position themselves. So, if we [the project owner] have good news, if things are going well in the company, then there’s a lot of interest, so I’ll say ‘it’s a good time to raise the money.’ In six months from now, who knows? It may be more difficult and I would say ‘I wish I had raised the money back, six or eight months ago.’ The timing is a big part of getting that right.  | Regarding investment horizons, the timing is essential for funds. The funds need to work for usually invest for five years before exit, which for bio-tech is the wrong model. Now, as for venture capital trusts (VCTs) (a tax-efficient vehicle open to the general public usually managed by commercial operators), they probably embody the best model to invest in bio-tech. They raise money from the general public, they have tax advantages, and they destine their moneys to SMEs. 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However, venture investors in this space like to get in early because they have funds of a size that they know over the life of the investment they can deploy enough capital to. Also, it’s the cheaper time to buy; buying late is more expensive, buying early and being there to follow your money, you’re going to have a biggest stake in the returns and, therefore, the best returns. VCTs realise it’s about filling the product pipelines for big pharma because they are your customers, they are the guys that are going to buy your business. And those guys have started to come earlier. Investment time horizons tend to be also fund-specific. In technology industries (including therapeutics), perhaps with the exception of software-type businesses, if you are an early stage investor, your time horizon should be five to seven years. This is pretty challenging when you are in a ten year fund because it leaves you no leeway. A ten year limited liability sort of vehicle is quite hard to make work for if you are going to do C-stage (clinical) therapeutic type
are already investors, if there have been investors in round one, and I get to round two and they want to do this deal again and they have the right to do so, and you want to bring other investors, that can take a while because there has to be a lot of negotiations... so that's the complicated part. That's all politics.

As an investor, it is very important to get in early, at the right stage, because they need to mind if it is wrong. There is no point in getting the VC to invest early and then he cannot follow on because you need to get your 20 or 25% on the ground because you are going to get diluted, fine... but if you can follow on to the next round, that is where you start to build...

... so, it is very important that there are VCs in just at the right time but equally it is important to get the stake in the ground.

For follow on rounds, I would say almost every investor who does early stage biotech, a serious investor would do follow on unless there is some strategic issue why they cannot so things are taking so long and the follow on is too late and the fund could not raise it ... you know, funds are constituted for 10 years, they have 5 years investment, 5 years realisation... if they invest into discovery at year 5 and now it has taken longer than expected and it is year 8, it is just about going to phase 2, maybe I would not follow on because then the investors would go for another one... maybe they would.

means selling the right to develop the drugs or products further. This is a way to shorten the long time scale.

Concerning follow on funding, it is a normal thing for funders to tranche around milestones so there is some greater clarity (for funding decisions). Initially, funds do not put in more than a third or half of their total funding capacity.

Concerning follow on funding, it is a normal thing for funders to tranche around milestones so there is some greater clarity (for funding decisions). Initially, funds do not put in more than a third or half of their total funding capacity.

Deals. Now early stage can mean as early as creating the company (meaning institutional angel money) and that is really hard in the biopharmaceutical sector because seed funds do not tend to be large by nature since, given the amount of rounds and the amount of money that it takes even if you create a successful business, you can end up not crystallising a great investment return given the time and preferences that you can alternatively use the money in. That is why if you are not a dedicated fund, exposure to life sciences would not tend to be in the full in therapeutics.

A good way to do it is to put a little seed capital into a project for a short term (4-5 months), that's the price to be paid in order to 'crystallise an opportunity that you really like... to pull the bits of the jigsaw puzzle together.' Then, they're ready to commit a larger amount of capital only if syndicated A round can be built so you put together enough capital to achieve what you are looking to achieve. However, it does depend on the sort of fund you are. Again, if funds have the right people in, they have the right skills to help build and shape a proposition and they know the seed money is not going to be abused - valuation wise because they've got enough way to capital to support the next round and hold the escalator up, and that's less risky for them. For the other funds, it might be sub-economic because even if you like the life sciences space, if you have two
Follow on is key here. It can also bring a new investor around, but essentially it is not about that.

So, in terms of syndication it has been a well-trodden path. Investors know each other and will be happy to syndicate. It is a case of timing, it is a case of come and put the right amount of money in the business...

A generalist fund just does not have the experience, they would not be able to add the value, they would probably challenge you for investing in a company, and they would not be able to follow on as much. But there are funds that have completely separate arms, so one is a life science and technology arm and they sit together in the same office, but the domain knowledge in each is very specific; one side of the team does these deals and the other side does not. Though that is fine, they have the expertise to follow on or not a given strategy.

We don’t have any limitations on time at all, so we can stick with companies for as long as we like. The question for us becomes one of managing those businesses toward the optimal outcome... so, for instance, if we were doing a therapeutics investment, we would be reasonably unlikely to take a therapeutics investment beyond the end of phase 2; however, if we were building a company that had revenues from sales and we were growing a business into the US or growing a business

... we have the regular pre-seed programme which you can obtain after having an exploratory pre-seed grant, but also most of the pre-seed projects come through us...

We have a few seed investments that have started as spin out from existing companies; so we have a couple of companies where... it is projects which have not fitted in bigger pharma companies and we took them up and then built a biotech company around them. But they don’t truly go through a pre-seed

So, we always co-invest but we always co-invest with groups that are very similar to us, groups that have got very experienced people, groups that have got sufficient money. So we see this as a partnership, not as a leader versus follower scenario. Sometimes we do use funds that are predominantly followers, and that maybe if we just want to top up a little bit of money, but we always build a 3 or 4 members syndicate with groups that look very similar to us and then we see that none... we co-lead in effect because, you

We tend to not create companies, we tend to invest in already existing companies. So we don’t create start-ups, we invest in start-ups when they need serious money. So this is due to a number of things. One is that we have, relatively speaking, quite a lot of money to invest. We can invest up to 50 million euros every year and there is only four of us. So, as a consequence, we tend to want to put between 5 and 10 million euros in play every time we invest because it takes as much time for us to do the work to invest
international, then we would not necessarily have any desire to sell them at all, in particular point in time as long as they continue to grow, so our mandate is slightly different to most others. I guess most of our historical companies that we’ve exited were exited via trade sale and most of the companies that we are building at the moment have targeted to exiting by trade sale. I guess our position is shifting slightly at the moment because fairly in the investor space and definitely in the US there is a more active public market. And so one or two of our businesses that are more mature may seem to go an IPO route, but they have not been built with that in mind, but with a trade sale in mind.

We are quoted, we are listed on AIM, so we have enough money to keep investing in businesses as they grow. We are proud to have the vision and capital to sit alongside relatively long business models in the technology sector.

So we can invest very early. Some of our projects around the therapeutics space... we might be creating a company in order to put the intellectual property into the company so we can then run some very early and repeat experiments of what’s going on in the academics’ lab. So this is a long way before we’ve even got a drug molecule. A lot of this is a translational period of research where the academics might struggle to get additional research phase, but will jump right into a seed investment. So, almost all the sources here are either universities or hospitals that are the source of that research.

We have that capability (to fund since a very early stage and to fund successive stages) which is also quite unique for the N Fund structure… that we can actually take research from the whole part of the chain here. The NN Foundation gives out basic research grants; we have the support of the two varieties of support and pre-seed grants. We get about, let us say in round numbers, 100 support and pre-seed grants applications every year and approximately 15 to 20 of those are actually funded, so that is quite a high percentage.

So, currently we have a portfolio of about 14 companies, maybe 20 or 25% of that have actually started as pre-seed projects. And I think that the quality of this has also shown that out of the… in our portfolio, some of the most interesting companies right now, they actually started as pre-seed projects. So we see a very valued work early with the teams and get the right direction in the development.

Nowadays the exit mode will almost always be a trade sale. … we are, you can say, an evergreen fund which allows us to have the patience and, in particular for know, we are all very experienced, we are financially solid groups, so it is a partnership rather than a leadership role.

… we will never follow in the sense that if another group has done, you know, has got a finance syndicate that we will never just say ‘ok, we will follow your money, we are pursuing as well’, we always do extremely detailed and lengthy due diligence in everything we do, whereas the followers tend to rely on groups like us, who do very lengthy due diligence and then follow us. … all of our funds, in common with many venture capital groups, are 10 year funds. So, in principle, that puts a cap on the holding period… … the way that we operate is that we tend to invest a new fund over the first 4 to 5 years of the life of the fund. And then we like to think of an exit in the 3 to 4 years’ time frame. … as I said, 4 to 5 years are fairly typical holding time, but there is positions (sic) within the fund to hold for much longer, so we have some companies that we’re held for 10 years. … that is what smaller funds really suffer because they get to appoint where they have exhausted their funds and yet they still have to continue to fund that company. … whenever we make an investment, we always reserve for subsequent financing round.

… you know IPOs and then also be an investor, because we are active in there, we take seats on board and we work for the company.

… until we have a larger team, which might happen in the future, we tend to invest in clinical trials basically.

… where we get deals from, I would say that three is three different sources. One is what will come to us and here is the question of how well known you are… … the more important source is when other investors come to us and say ‘we have a company we would like you to look at’; then you know that there has been some triage… … the third source is when we proactively look for things that is to say in an area, where we are interested in and we have sort of a little wish list of things we would like to invest in and we find something good.

… we are being measured on an IRR perspective. So, in principle we need to be yielding more returns on the limited partner we have, which is the foundation, that are greater than if they put the money in the bank or if they put the money in the hands of a financial manager, which is a question here as well. So from that perspective, time matters even if we are an evergreen investor in the sense that it is possible for us to stay an investor forever; it still has to make sense from a perspective of what the cost of money every year is. … [ITH] That is
grants to take their projects forward, but equally they are not as amenable to VC investment because they just don’t have the drug molecule.

the seed investments space, this is very important…

I think in life sciences the normal venture model with ten year funds fits poorly with early stage investment and that is actually why you see most venture funds are moving to the late stage investment because there is simply not sufficient flexibility with regard to time to exit.

in the US there is an IPO window right now, there has actually been one lately, but I think for… if you at our perspectives respect of NS, IPOs will not happen, that simply won’t happen, I cannot see it happening any… number at all … actually in Europe in the foreseeable future, so the exit will be sale to large pharma partners.

are very difficult and the IPO window has not been opened for a very long time, it is sort of opening a little bit now. We tend not to focus on IPOs because we see those more as a financing event rather than an exit. And we build companies for trade sale to pharma.

We prefer to pick up companies in mid stage research and finance them through to a phase 3 clinical proof of concept. But that is a generality; we do quite a few seed stage deals and we do quite a few late stage deals. But on the average, it is the late stage research through the clinical proof of concept where we tend to focus.

So you are putting a very big commitment into the company, you’re expecting to have a lot of influence, you know, and actually, you know, you’re also saying to your, in the case of an IPO, your shareholders, in the case of another VC fund, to his limited partners, you are saying, you know, ‘we have particular expertise, we have access to broad networks to do the due diligence; you know, the reason you are backing us is because of our… because we are a public funded body, I am paid through the taxation system so on, that means that we don’t have to fund just projects that will have a large financial return directly, so we can look at things that have benefit for the society and the economy more broadly, which means that the type of projects that we fund… they are probably broader than what a venture capitalist would fund and it means that we can be more adventurous in what we invest sixty million DK which is equivalent to six million pounds per company, so it is quite a… we are able to follow, you know, the seed companies quite far in the investment life cycle, you could say; we try to syndicate early with the European investors…

…if you want to co-invest, you generally want somebody with sector-specific experience and expertise; you don’t, in our field, generally pretty much between 4 years and 6. [As for the preferred mode of exit.] We absolutely prefer the trade sale and we prefer that to be as much up front as possible…

… going through the public market is, of course, a different game… and right now, right these months in biotech the markets are open and that is a possibility, but it is not… I deem it is not necessarily an exit for an investor… a liquidation event. And then you have to get out of your stock and that is when an investor is usually locked up for six to twelve months and you have to be sure that the window is still there and that the assets are liquid so you can trade out without damaging the share price, which is an art in itself.

… there is a gap, there is a financing chasm. The government and the business angels can take projects only so far and if we do not invest in projects that get to that point, then there is a problem in the future.

We can get involved as soon as they have had a patent filed. But more typically we would be involved at a stage without formally investing and we would probably get to a point where there is… soon after the patent filing where we will invest enough… probably that would be a little bit more typical. But in terms of how far the technology is gone, quite typically there’s been some initial experiments performed in academia. So, in life

As for… if you are a public company, you know, rarely anymore these things are going to float… you know, that was ten or twenty years ago; nowadays you are building companies that will be effectively… you know, you hope are bought by a large player for whom the advanced technology or product will satisfy strategic requirements in the market.

Also, you need to be aware of the active… so having a corporate investor… Now that is different if it is a
| science things like therapeutics or biomarkers or anything like that, there would not have been anything like toxicology or any kind of ISO standard testing done. It’s really… it would be extremely unusual for anything to be any one year of clinic… it’s likely to be in the animal studies… less likely in clinic. So it is very early.

… we believe we’ve got a model that works and our model is based on the fact that we believe there is a lot of good science in the UK universities that is not being exploited properly and we believe we know how to exploit that…

So, we don’t have a formal investment horizon because we invest in sort of a balance sheet, so we don’t have a fund that has a need to timeline if you like.

We have… we also have other funds that we manage effectively through… so, for instance, we have just raised a million pounds of venture funding for a year with an investment bank which invests alongside us, which gives us a fund which is very well connected and… then we can go out and syndicate that project with other companies.

particular insights into this domain. We are not going to take anybody else’s word for good, we are going to figure out ourselves, we are going to do the… do the work on the deal and then, if we get comfortable, then we are ready to lead that deal we’ve negotiated. You know, with the diligence package, with negotiated terms and… well, we are very well connected and… then we can go out and syndicate that project with other companies.

we fund.

want, at the early stage at least, a generalist; at the latest stage, generalist investors are good because they generally have deeper pockets and they… they are good if you want to take a company public because ideally you want a few generalist investors in an IPO. But at the early stage, which is where we focus on, yeah, you want to syndicate the deal and you want to do with sector specialists.

NNN is an evergreen fund structure, so we don’t have any limitation of ten-year life of the fund (sic) but we do, with our co-investors, we like to seek return on our investments in, you know, within a reasonable time frame so five or seven years, I think, it would be a good number. So, whenever we look at investment, we evaluate, you know… how long time we need to stay in order to be able to sell or exit this company, what sort of inflection points do we need, you know, need to reach… it could be a clinical, you know…

I think we go in very early, I mean… we often have an opinion on how the business plan should be composed and the more we understand about it is because… it is the better we interact with the team; so it is basically a… the ideal situation is that the interaction between our questions and trying to understand the subtleties of the opportunity will actually improve the business plan that the people come forth with. We don’t write the business plan, of course, but we interact a lot, and

venture capital arm of a corporation. So several types of companies, you know, pharma companies and others have venture capital divisions and they will do two types of investment, you know, it is different from each company. Some will do strategic investments, ones where they will have the opportunity to acquire the technology once it has achieved proof of concept. The challenge there is to make sure that they don’t have pre-emptive rights… meaning that you and they are all on board or they are usually an observer, they just have early insight into something and hopefully develop a relationship with the management team that gives them an edge on the deal. If they invest only to have pre-emptive rights downstream, then it can be a challenge and VCs typically don’t like that.
For our current fund, we are investing from 2011... venture fund... 200 million pounds just under three years ago. The strategy for that fund is really ninety percent gross equity and by gross equity what we mean is investing between five and fifty million pounds in businesses with revenue of more than five million pounds per annum and at or approaching break even... and we are looking for these businesses to be growing at at least twenty percent per annum.

As we have changed our strategy over the years and moved more towards what we call 'gross equity', which is our... our strategy toward more mature deals so as to recruit revenue generating businesses and... that has changed quite a lot, so we've just analysed our deal flow through... maybe through the last year, and quite interestingly we see that it roughly has started... our sort of deal flow is originated by us... so, in other words, we are going out proactively looking for companies with a certain profile or in a certain sector, we are approaching them... We are typically improve, and expect, you know... a mutual collaboration of devising... figuring out what is the right direction for the project.

Well, my company invests... we specialise in very early and early stage. So that means from companies that have even not been formed yet... so with the goal of setting the company up, to companies that are in R&D product development stage. We have a few late stage companies in our portfolio, probably about five and which we originally invested in early and they've grown until now to late stage. But generally, when we come in, we invest early.

No [not any particular preferences imposed by the markets] so... we can hold investments for longer than any normal limited partnership because we are balance sheet investors, so we don't have a fixed horizon for exit. We, normally, we take seven to ten years to be about the right time to build the company to a significant value and for an exit. We are happy to... the ideal exit is trade sales because then we get liquidity, but an IPO... IPOs are an option now. So, the IPO versus the trade sale is largely driven by markets...

The IPO in itself is not an exit because the investor usually... improve, and expect, you know... a mutual collaboration of devising... figuring out what is the right direction for the project.

Angel investors typically get involved in early stage but it depends on the area; they typically do not like to get involved in early stage therapeutics deals because it is so capital intensive and their investment can get diluted out by a second round of financing. VC is... typically have more funds to put in and so they can keep up their pro rata share of the company if second rounds of capital are required. So, really, the best source is venture capital money because they have... the funds to get a company to a successful exit and the exit being either an IPO or an acquisition.

Most venture capitalists are interested in, from a bio-tech point of view, in a very fast turnaround of their money.

Twenty years ago, it really was an exit point for venture capitalists, but it is not now. And, although it was not our case, I've seen many IPOs where the only way to actually get done is when the venture capitalist invests in the IPO... and to me that is really... you know, a strange concept.
that entrepreneurial background, we understand the special issues of starting and working with very young companies… Some venture capitalists, you know, they simple don’t have that background, don’t have that interest in, think it is too risky. The reason they think it is too risky is because they think they can only sell a product if it’s… if they take it all the way to the late stage. We don’t invest in early stage stuff with the idea that we are going to… you know, stay in for ten years and take it all to a late stage; we invest in early stage companies only where we believe that we can sell it as an early stage company, so that we enter and exit still in the early stages, you know, if we thought that we would only able to exit at a late stage, we’d tell the companies to come back to us in a few years where… you know, one or two rounds less to exit…

Now, we do have some late stage companies that have gone public and have done very well and we’ve considered them successfully, so that is an end option. But what I would say is that the environment of the public markets, particularly the public markets in Europe, which have been a little less open to bio-tech IPOs and the NASDAQ has been a little last year, so that… we look at trade sales as the focus of exit discussions and then if there is an IPO opportunity that is sort of… I think, under-catered, it is a second option that we were not counting on…

has a twelve month lock up period and… you can only sell your share when that period ends and there is no guarantee the share price is going to go up, it might go down. So it is… it is not an exit; it is only a way to get some cash back.

The general opinion is that it, [CVC funding early stage] is a good thing. I think that pharma has half or two thirds of all biotech firms now, have at least one corporate firm in syndicate.

understand where in the fund cycle an investment is coming out at; so a VC fund has ten year term… meaning that all capital needs to be returned to the limited partners, which are the individuals or typically large endowment funds and so forth that will invest in a venture capital fund. If an investor is investing out of a fund that is later in its cycle, that can be challenging because there can be a misalignment of interests in the board.

If you have three VCs on the board of directors, one of them who invested very late out of their funds and the other ones very early, there is going to be a misalignment of interest… because when the investor late out of their fund is going to be… very eager to get an early return because they have to either raise a new fund or they have to return the capital to their limited partners. And if that is the case, they may want to push the company to an early exit that may not be in the best interest of all the shareholders.

Hmm, well, the preference [exit] for any VC more often than not is going to be an acquisition. VCs will have preferred shares; in an acquisition, the rights that are associated with preferred shares will be reflected in their exit. So, often you see things like, you know preference rights, towards preference rights, which means that venture capitalists will get two times their investment before any… the common shareholders get, you know, get rewarded.
IPOs are no longer an exit. VCs that cannot sell shares into the IPO, they have to hold that and more often than not have to invest alongside with public investors. They are also going to be subject to a harder degree of lock up, meaning… you know, the can’t sell or buy shares for 180 days… half a year following the IPO. If they are on the board, they still can’t sell shares because that will reflect very poorly on the company. So an IPO is not an exit for them; what they can hope is that at some point they can transition off the board.

Source: Author’s own elaboration
Table 19 – Trends of change – excerpts from interviews

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<td>So you work with a lot of different investors over a period of 10, 12, 15 years and you get to see a lot of mechanics at operation… I would say complexity has changed, the number of people has also changed who are in the area, who are providing funding, investment, a lot more than they were.</td>
<td>... in the academic sector the feeling is that money is completely dried out. It's gone from the feeling that you had a 1 in 3 chance of getting a grant funded to a 1 in 15 chance of getting a grant funded, so the odds are very much against you. On the positive side, the costs of risky investment that the funders are making, they are looking for returns not in 5 years but closer to 10 years down the line and so an immediate economic crisis that has an impact over 2 or 3 years does not affect the decision making in the same way as it does for central government...</td>
<td>Government funding programmes have slightly improved over time [in France]. Instead, there seems to be much less private money (VCs in general) available today, particularly after the 2008 crisis hit Europe. ... private funders never asked you to put your own money into the project in the past; nowadays, they demand that you yourself put money into the project. The problem is, what if you do not have any money, just the idea/knowledge? So the problem today is how to get access to the existing funds.</td>
<td>If [stratified medicine] is a very influential approach because it means, in some cases, some therapies have to be complete re-designed and in others, new therapies, they have to be targeted for specific proteins so diagnostic tests have to be developed to prove the effectiveness of a drug according to the type of patient condition. This has a powerful impact on funding since it means that drug companies have to work closely with diagnostic companies. There is a lot of nervousness in VC with regard to diagnostic companies because the business model is not understood. ... there seems to be no clarity about who is going to pay for the test (the drug company, the NHS?)... a lot of people are concerned about how will diagnostics work as a developing industry. ... the move is towards a disease panel, so you come into the clinic and you’re diagnosed with rheumatoid arthritis, for example, then you’ll be given a panel of tests that give you specific treatment options based on the efficacy and potential toxicity, so there are different options... it is not about just one drug, it is about looking at the disease as a whole and the patient as a whole. So, if that is the case, then it becomes even more challenging because then the drug companies are less interested, potentially, in funding the development of the</td>
<td>It [the Investment Time Horizon] is getting shorter, I think, because pharma is doing acquisition... So, when you start phase II, you can get acquired, half-way through phase II you can get acquired.</td>
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<td>There’s been a move away from large headcount bio-tech companies to not much headcount but lots of experience. The industry is quite fragmented, so there is a contract organisation for every aspect of it. So VC funds do not want twenty expensive chemists doing stuff, while we can do this in controlled outsource packages. What we need are really experienced people to decide what the program is, what the project is, and who and how we outsource. ... There’s a lot more alignment to... unless pharma invest early, given that nobody else was doing it, there wouldn’t be anything to fill the pipelines and that’s in their self-interest.</td>
<td>so the feeding, in other words, the IPO feed to AIM stopped. And the exit from the other side has continued, those coming in have continued to grow or they’ve fallen away, so it depends... while the climate has changed, it’s become more difficult to IPO. The other major sort of positive move a realisation in the pharmaceutical companies that they are not good at high level innovation. So around the globe every pharmaceutical company is scaling back its research activity and using the funds that are being released by doing that to acquire assets at the biotech companies. So that is another very, very positive trend for us because we have a... there is a pharmaceutical industry that is hungry for our... the assets that we are building in our companies.</td>
<td>If I look at early stage life science, it is only dedicated investors that can prevail in this. I still hope that in the later stages and also... we do, of course, seed funds and it is very common for venture funds to have an IT and a life science team. ... I think still this is an area where there can be made very good, very profitable investments, but historically it has just turned out that the public general investment market is not... does not really understand the life science sector very well. ... if you look within Europe, there is a fairly fragmented market, really there is a dire need of more cross-European venture funds. Right now the European market is alive, I mean it is not dead, but it is fragmented and uncertain... ... we’ve seen very much in the form of less venture funds, good venture funds that are closing not getting... not being able to raise new funds or new funds being raised at significantly lower levels and... so it is a problem...</td>
<td>... the risk in a particular project have gone up over the years. It is predominantly a regulatory risk because, you know, the regulatory agencies are wanting ever more safer molecules so that means you have to invest a lot more money to get drugs that are truly well tolerated; and it is also the regulatory environment which is saying, you know, it is important that your drugs are truly differentiated from everyone else’s drugs, so the era of the me-too drugs has disappeared or is disappearing quickly and that, again, puts a lot of pressure on companies because to get higher quality compounds whether it be only efficacy side or the safety side requires a higher level of investment. And not only is it a higher level of investment, but there is a greater chance of failure.</td>
<td>right now, the lack of access to capital so that is a good situation for investors because there is obviously... seldom will there be competing because all of them will want to invest, you know, it rather is that those who are interested will join forces and co-invest... going back five years there was always competition, so that is good for investors, bad for companies.</td>
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in general, the investors in biotech are very nervous about biotech because they see it is now too high a risk; so the amount of money that is available to the venture community to invest in this type of activities is falling and particularly so in Europe. So that has an effect on all, of course, because there are fewer people around with which we can build syndicates.

... [regarding] personalised medicine ... actually there are multiple forms of asthma and you need developing drugs to attack each form. But that in itself brings in extra risk because you need to be sure you understand how the different forms of the disease manage that themselves, and what the underlying mechanisms are, and of course it is a smaller market, so there are... commercial diffusion will be going that route, you need to charge a higher price for a smaller number of patients. And also the regulatory routes are not that well defined for these sub-groups or targeting medicine, so the risk goes up in personalised medicine. It is a big opportunity, but you should not forget that the risks are higher.

What has changed, I think, is of course the risk profile both of the people and investors; so forth it has changed dramatically... that is, I think it was needed some way... we don’t need the financial crisis, I don’t say that, but I think the changes have actually been healthy for the

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| I think there has been a huge dip in the access to funding from private investors primarily, live venture funds and private people investing in pharmaceutical development. And I think that now we are getting to... sort of change again... now you see more money moving into the industry as a whole has mutated from the brighter times of sort of 2005/2006, where you could raise money, lots of money, on the back of ideas... which you just simply can’t do anymore. There is a massive competition out there, there are lots of companies that want that money and there when I got involved in the industry, there were a small number of pharmaceutical companies, then that became smaller as the companies merged with each other and there was a relatively... relatively small number of places you could produce, and we actually put in measures, metrics indicators on how

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| I think the industry as | So, probably in the late nineties, early two thousands the strategy policy was very much on creating spinout companies and universities were actually measured by the number of companies they would produce, and we actually put in measures, metrics indicators on how
industry. So I think that less projects are actually being developed into companies, so we had a period when many companies just developed and maybe we did not need to actually start so many companies. So I think there is a change in the mindset regarding this. Now fewer companies are started, the ones that are being started have better plans, more thought and so on. So people are thinking more before starting a company, which I think is quite important and... of course, what the crisis also did was to actually to close a lot of the companies that should never have been started.

healthcare and pharmaceutical development, too. So I think there are good sort of trends at the moment. But it is not... it can be better than it is now, and I think it will become better... I think this is a huge opportunity looking at the long term.

is not that much money available any more.

I think universities and their research basis have become much more aware of the potential value of what they do, so I think the awareness of IP has become much more... much better. But I think, at the same time, universities have no idea of what it actually takes to take these ideas to markets; so there is still a massive divide in terms of what they value those things at and what indirectly they are valued at by the market, if you like.

work as a sort of healthcare specialist. I mean, you kind of worked for pharmaceutical companies and actually that has been a revolution in terms of the whole bio-tech industry. I mean, there are lots and lots of places, you know, which are pretty more entrepreneurial...

... people say that there are less investors or there is less investment, It does not seem to me to be significantly different to... I suppose there are recently a big number of specialist life science... yeah, investors. That is the point, isn’t it? But I think that was always the case actually. I think that there is investment out there, you know, for a really good proposition.

many companies have you produced in this area. And that very much drove behaviour; that probably... And then the crash came in 2007-2009ish and during that time we were re-evaluating... actually, spinning out the company and creating a company itself may not be the most appropriate way...

So, I would expect there to be now fewer spin out companies and a lot more partnering with companies that are already in existence to share that technology, that idea. So yes, there has probably been a change in strategy where we don’t expect everything to be commercial, some could be given away freely because it is publicly funded, we don’t require to get commercial returns and the ideas can be given away freely, and there would be a lot more licensing deals and fewer spin out companies.

I would say that what is happening now is that organisations are pooling resources a lot more, so we fund a lot of projects at a higher level...

I think that [stratified medicine leading towards personalised treatments] is that definitely is going to be something that is going to be quite big... personalised medicine, and that will be a way of pooling resources more effectively so that makes organisations such as... nice and easier to decide what drugs to invest in and develop more effectively.

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clearly more difficult to raise money and the biggest problem, I think, in European bio-pharma, is the number of venture funds that there are out there. It is very very limited, so the competition is very high. On the other hand, I think, compared to... you know... ten years ago, the quality of the projects that we see is much higher. And the people are much more careful about the way they spend the money. ...

been changes in the life science industry, but also changes in the world of venture capital... from the life sciences side, I think unfortunately there was a lot of excitement, obviously, on the back of the sequencing of the human genome, there was a lot of money put into discovering new targets, new genetic targets and, you know, trying to kind of identifying new... new drugs or biologicals, but that has proved to be a much harder job than, I think, everybody had assumed...

... So, I guess, we saw a lot of companies at that time that were investing very heavily in relatively early phase research but were struggling, I guess, to get a sort of swift, clean development candidate at the other side of what they have taken for clinical development. So that, I guess, was very expensive and, I guess, the success rate was not great from an investor's point of view... So, it meant that the capital available in venture capital, and specifically in life sciences and healthcare, reduced significantly really between 2000/2002 and 2006/2007.

successful commercial drug development have gone up, the regulatory hurdles have gone up, it is increasingly difficult for companies to get products approved for payment, but they’re (?) in other states, and big pharma have become very selective as they (?) a lot of profit... generate a lot profit themselves, so they are very selective about the programmes they choose to buy. So it has become more difficult to generate very high value trade sale. So, a lot has changed in the States and, as a consequence of that, the whole investors’ metrics have changed accordingly.

I think, increasingly, the use of new technologies such as the use of biomarkers disaggregating the segment patient populations and to improve the success wait of drugs will be used a lot.

the NASDAQ bio-tech boom has generated more favourable feelings about bio-tech, generated some exits for venture capitalists and, I think, the pension funds and endowment funds and other investors that put money into venture capital funds are probably feeling a bit better about our sector than they did five or six years ago. And so that will make more capital available as this is an incredibly capital intensive business and... so that’s... that’s the positive thing.

The potential negative thing is that increasingly the US is becoming the principal marketplace for high value, novel therapeutic products that nice and similar European agencies are... I think for very good reasons and you figure the public health demands on it, but they are just not paying for stuff...

... and my concern about the future, not the next five years but in the next twenty years is that at some point drug development is going to get too expensive for the health systems to pay for it and it is just going to stop happening,

Well, the most important [change] is the regulatory environment. You know, it is rather different people... they make a mistake, they are looking at the FDA as one entity while, in fact, the FDA as well as the European Medicines Group, the EMA, our cyberbongs, they are broken up into divisions, therapeutic

I think that obviously orphan status drugs are blooming right now. People see that you don’t need to have a huge population affected with the disease... you know, it is a situation of whereby it is a pricing incentive of market and subsequently I think we will see continued trends up in the orphan status.

... six months ago I’d have to say no, no one was getting problems and you had to... It has changed for the VCs, this is true. It has not changed for companies so much, but it has changed for the VCs’... And the reason is that there is the VC model items where you can take something through to a phase II clinical

In the last... probably from 2010, there are a lot of companies that need the funding but not many funders, not many investors with cash...
area divisions. Each of those divisions are going to have a… you know, their own issues...

Well, obviously in the US the affordable care act is going to have a major impact; the requirement for everyone to have medical insurance and have it (?) ordered by the government, that is going to have a huge impact in the bio-pharmaceutical field.

If the FDA found that whatever drug you are developing is only suitable for a very small sub-population [as is bound to happen with personalised therapies], then you don’t have to market outside of that so you should be able to decrease your commercialisation costs; on the other end you could command a higher price because it could be a very small patient population that would be cured by your particular drug.

I know that SSS this morning bought a relatively small company called VP, a bit like fifty dollars a share, so a couple of billion dollars in a company that was only a couple hundred of millions maybe three years ago, but they got a drug approved for, you know, an indication where there is only about ten thousand people, in the United States it happened but, you know, they got bought for a couple billions. I think you will continue to see that because there is a lot of orphan status diseases out there that have never had drugs developed for that...

I think the agency, the FDA specifically now has really moved to grant much faster regulatory times and reduced for drugs that are being [tested] on unmet medical needs, when there is nothing; I think they really improved in fast tracks status, I think that will bring the market to start looking at drugs where, you know, there is such an unmet medical need...

changed things a bit because there really was access to the public market and people were in the position to get to the public market this year and they did OK...

… you know, in 2010 people did not want to invest in early stage because they did not see any opportunity to get out at a profit. The main change, as I said, a little bit this year and, you know, I have to honestly say that investors seem to have pretty short memories. So even when they got burned on something a decade ago, does not mean they don’t want to take a crack at it now.

trial or even into a phase III and look at… at that point you are going to be acquired by one of the big phamas or you are going to go public. And then what happened is the big phamas kind of got tired of being completely excluded over by VC-backed companies and…

So the whole environment was possibly quite tough for the VCs because rather than funding some deal into phase II, they are potentially funding it to a much later stage, which is difficult. I mean, that is not what they intend. Now, now the VC... now the IPO window is open, but the IPOs that are getting done tend to be funding IPOs, not cashing out IPOs. So, again, the VCs have to be a bit more patient before they cash out…

I think a lot of it is determined by the acquisition appetite of big phama or mid cap phama. The more big phama wants to do acquisitions or collaborations or whatever, the more it is going to be funding early stage things that much easier. And I actually think that given the appalling productivity of big phama, they are going to be progressively driven to do more and more deals with smaller companies.

Source: Author’s own elaboration
2. PARTICIPANT’S FORMS

A SECTORAL APPROACH TO THE FINANCING OF INNOVATION: STRATEGIC INTERACTIONS IN THE FUNDING OF BIOPHARMACEUTICAL SMEs

Participant Information Sheet

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the research?

SIERRA GONZALEZ, JAIME HUMBERTO, Manchester Business School

Title of the Research

A SECTORAL APPROACH TO THE FINANCING OF INNOVATION: STRATEGIC INTERACTIONS IN THE FUNDING OF BIOPHARMACEUTICAL SMEs

What is the aim of the research?

This research project will study how decisions on innovation funding are affected by strategy and interactions between project owners (established SMEs and start-ups that belong in one sector and for which innovation is a strategic activity) and external financiers within a network of influential factors that affect the bio-pharma sector.

Why have I been chosen?

You are part of a sector in which highly innovative projects are regularly undertaken and where intra-sectoral differences among actors are a key feature.

What would I be asked to do if I took part?

You will be asked to participate in an interview and provide your views on how funding decisions are made in your company. You may be asked to provide some data to support your views.

What happens to the data collected?

The data collected will complement secondary data gathered elsewhere.

Primary and secondary information collected will be codified and, afterwards, will be used in an analytical report that will be used to inform and complete the theoretical framework constructed. A case report will be written for each enterprise-project-financier case and cross-case conclusions will be drawn after comparison of such cases.
Subsequently, the theoretical framework devised will be reviewed and enriched on the basis of the analytical results and implications for the actors in the system and the sector as a whole will be developed;

All primary data will be safely stored during the research process and will be held from distribution. Only analytical results will be circulated.

**How is confidentiality maintained?**

All primary and secondary data will be handled only by the researcher. This is an individual project, so no other person will have access to data. Data used in the project will be stored in and accessed through a university password-protected computer located in a single office. Such data will not be shared with anyone under any format; it will only be used to complete the research project described above.

No raw data will be reported. Only elaborated data and their analysis will be eventually used as output. Also, no company names or other identification data shall be used in reporting the results of statistical analysis. The analysis will refer to sectors, not to individual firms, so references will be made only to aggregate groups of data (sectoral means, deviations, etc.).

In general, all good practice measures requested by the participants and the University of Manchester are applicable and will be implemented. All information stored will be destroyed and no records will be kept after the study is finished.

**What happens if I do not want to take part or if I change my mind?**

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason and without detriment to yourself.

**Will I be paid for participating in the research?**

No payment will be made.

**What is the duration of the research?**

Individual interviews will take approximately one hour.

**Where will the research be conducted?**

Individual interviews will take place in a location at your convenience.

**Will the outcomes of the research be published?**

Outcomes are expected to be published in a peer-reviewed journal or a similar scientific publication.

**Criminal Records Check (if applicable)**

*N/A*

**Contact for further information**
What if something goes wrong?

Same as above.

*If a participant wants to make a formal complaint about the conduct of the research they should contact the Head of the Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL.*
A SECTORAL APPROACH TO THE FINANCING OF INNOVATION: 
STRATEGIC INTERACTIONS IN THE FUNDING OF 
BIOPHARMACEUTICAL SMEs

CONSENT FORM

If you are happy to participate please complete and sign the consent form below

1. I confirm that I have read the attached information sheet on the above project and have had the opportunity to consider the information, ask questions and had these answered satisfactorily.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason.

3. I consent to audio-taping the interview.

4. I agree to take part in the above project.

Name of participant ___________________________ Date ______________ Signature ___________________________

Name of person taking consent ___________________________ Date ______________ Signature ___________________________
Q1 – How do you get to know about potentially interesting investment opportunities in the BP (or any other) sector? Do you usually look for and contact BP firms about innovative projects or just wait for them to contact you?

Prompts:
- Networks used to find potential investment projects

Q2 - What is your average investment time horizon (years) and your preferred exit form from this kind of projects? Do you prefer to fund a seed-stage company, a start-up or an established firm? At which project stage (PC, CT1, CT2, CT3, PR, PostRD) do you prefer providing funding and why?

Q3 - What is your key criteria when considering an innovative R&D bio-pharmaceutical project/portfolio (project characteristics, team, prospective profitability, other factors)? How do you make decisions to put money into them or not?

Prompts:
- Role of uncertainty, risk, potential profit, costs, technical feasibility, people, other issues.

Q4 - Do you compete with other funding sources or you consider investing together with them? Which? Why?

Prompts:
- How is coordination achieved in that situation?
INTERVIEW GUIDE - MANAGERS

PRE-INTERVIEW QUESTIONNAIRE

(To be sent over an e-mail after having obtained a positive answer from the company management about the interview).

How many projects make up your current R&D pipeline? (I might give options: 1, 2-5, >5)

Could you say how many R&D projects have reached the stages below:

<table>
<thead>
<tr>
<th>Stage</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preclinical</td>
<td></td>
</tr>
<tr>
<td>Clinical Trial 1</td>
<td></td>
</tr>
<tr>
<td>Clinical Trial 2</td>
<td></td>
</tr>
<tr>
<td>Clinical Trial 3</td>
<td></td>
</tr>
<tr>
<td>Pre-registration</td>
<td></td>
</tr>
<tr>
<td>Market</td>
<td></td>
</tr>
</tbody>
</table>

Could you make a general description of the 3 most important projects?

<table>
<thead>
<tr>
<th>Project</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P1:</td>
<td></td>
</tr>
<tr>
<td>P2:</td>
<td></td>
</tr>
<tr>
<td>P3:</td>
<td></td>
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</tbody>
</table>

Do you know of any other company working on similar projects (out of the 3 most important) currently?
Q1 – Under what circumstances do you preferentially seek funding from: government agencies, banks, other companies, specialised investors, non-specialised investors?

<table>
<thead>
<tr>
<th>Financing Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government funds</td>
</tr>
<tr>
<td>Other companies’ funds</td>
</tr>
<tr>
<td>Bank loans</td>
</tr>
<tr>
<td>Specialised investors</td>
</tr>
<tr>
<td>Non specialised investors</td>
</tr>
</tbody>
</table>

In your opinion, what financing sources have a better disposition to fund projects in preclinical stage (PC), clinical trial 1 (CT1), clinical trial 2 (CT2), clinical trial 3 (CT3), pre-registration (PR), non R&D activities (e.g., market development) (PostRD)?
<table>
<thead>
<tr>
<th>Government funds</th>
<th>Seed capital</th>
<th>Subsidies</th>
<th>Public venture capital</th>
<th>Low cost credit</th>
<th>Grants</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other companies’ funds</td>
<td>Joint Venture funds</td>
<td>Outsourcing contracts</td>
<td>M&amp;A</td>
<td>Bank loans</td>
<td>Specialised investors</td>
<td>Bond issuance</td>
</tr>
<tr>
<td>Non specialised investors</td>
<td>Family and friends’ funds</td>
<td>Grants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prompts:
- Sources NOT used and reason
- Is it easy to find different funders for successive project stages?

Q2 - How and where do you look for and contact potential external funders? Do you contact one or more funders simultaneously?
Do you know financiers with whom you have a strong, long-term relation? If not, how do you convince them to put money into your projects/company? How do you induce them into reaching an agreement?

Prompts:
- Main difficulties to find/contact external financiers
- Do you make them aware that other funders are/may be interested? Why?
- Have financiers started contact with you on their own initiative?
- How important is evidence of accomplishment to obtain external financing?

Q3 - What do external financiers want to know about your R&D projects and company before investing? How has this changed with the financial crisis? How do you gather information about financiers’ true interest in your project/company?

Prompts:
- Perception of fundamental uncertainty, risk, potential profit, technical feasibility, market and demand, or other issues related to innovative projects for internal and external financiers.
Q1 - In your experience, which sources of funding (government agencies, banks, other companies, specialised investors, non-specialised investors) are sought most often by innovative bio-pharma project owners (SMEs) and why?

Prompts:
- Which are better suited to the sector and why?
- Any changes along time/related to variations in industry or firm characteristics?

Q2 - Given the characteristics of BP innovative projects/portfolios (uncertainty, risk, costs, time horizon), how are they usually assessed by external financiers? On which basis do they decide to put money into those projects or not?

Prompts:
- How do they assess the salient characteristics of innovative projects (uncertainty, innovation, end result, usage setting, R&D placement)?

Q3 – How do external funders and SMEs interact, negotiate and agree on investing in innovative projects?

Prompts:
- How present interactions and decisions shape future ones and modify the sectoral innovation path.

Q4 – How feasible is the convergence of different types of funding (e.g., public and private) in the bio-pharma sector, particularly in SMEs? Is there any particular “optimal” scheme? Why?

Prompts:
- Analyse the crowding in/out effects of public funds being combined with private resources.