



POLITECNICO
MILANO 1863

School of Industrial and Information Engineering
Master of Science in Management Engineering

**The Determinants of Venture Capital Pre-
money Valuation: The Case of European
Biotechnology Start-ups**

Supervisor:

Prof. Francesca Tenca

Master Graduation Thesis by:

Eleonora Ferrari 904852

Matteo Segnani 884157

Academic Year 2018-2019

To our families

Acknowledgements

We seize this opportunity to express our gratitude to everyone who assisted us throughout the academic journey that led us to the achievement of a personal and professional goal.

We are thankful to Professor Francesca Tenca for her constant guidance and friendly advice during the project work. We are sincerely grateful for the support she provided us.

Not to mention, the support from our beloved families, friends and partners, who supported us during moments of discouragement.

Thanks also to all the mates and professors we met along these unforgettable years.

They transformed an academic path in a wonderful experience.

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Abstract

Venture capitals are fundamental actors in the entrepreneurial finance ecosystem. They accelerate start-ups' growth by providing them with money in exchange for equity.

It has been widely demonstrated by prior literature that the matching process between start-ups and VCs is strongly influenced by information asymmetry. For this reason, both start-ups and VCs can provide specific factors, i.e. "signals", to the other party to certify their quality (Signalling Theory). Our analysis focuses on how different characteristics of start-ups and VCs influence different stages of financing, with particular attention to the early stages of the pre-money valuation. We consider a sample of 103 observations of investment rounds conducted between VCs and biotech start-ups in the European market.

We explore which signals determine the start-up's valuation and identify specific factors that can be divided into three categories summarizing specific characteristics of the start-up and the VC. The first two categories include non-financial information that refers to the founders' attributes (Education and Experience) that influence VCs' valuation and

are considered of great significance for investors, especially in the early stages (Hand, 2005). The third one relates to the Experience of the VC, which, instead, influences the start-up's selection process of investors. Entrepreneurs evaluate investors not only on the basis of their financial offer but also on the value-adding services and skills they can provide to the company (Hsu, 2004).

We document that an entrepreneurial team member with a managerial education has a positive effect on the pre-money valuation. In addition, referring to the experience, we show that different types of previous expertise have a different impact on the pre-money valuation. The presence of a founder with previous experience as a top-tier manager in the same industry of the focal start-up or with previous experience as venture capital has a negative effect on the pre-money valuation. In the same way, even the previous experience as a founder of a start-up in a different industry of the newly founded company has a negative effect, while conversely, the expertise in the same industry has a positive one. Finally, VC experience, analysed in terms of companies invested and VC age, has a negative effect on the pre-money valuation. Overall, our findings inform researchers and policy-makers of the importance of non-financial characteristics, of both start-ups and VCs, in the definition of the pre-money valuation. Moreover, from a theoretical point of view, it is fundamental to underline how distinct signalling factors, in the same category considered, can have a completely different impact, positive or negative, on the pre-money valuation. For this reason, both actors must be able to communicate with each other as accurately as possible.

Keywords: VC, Venture capital, Start-ups, Valuation, Pre-money, Signalling Theory

Abstract (Italian)

I *venture capitals* sono attori fondamentali nell'ecosistema della finanza imprenditoriale, poiché accelerano la crescita delle start-up fornendo loro denaro in cambio di *equity*.

È stato ampiamente dimostrato nella letteratura come il processo di abbinamento tra start-up e VC sia fortemente influenzato dall'asimmetria informativa. Per questo motivo, sia le start-up che i VC possono fornire alla controparte fattori specifici, come “segnali”, per certificare la propria qualità (Teoria dei Segnali). L'analisi svolta si concentra su come le diverse caratteristiche delle start-up e dei VC influenzino le diverse fasi di finanziamento, con particolare attenzione agli *early-stages* della *pre-money valuation*. Consideriamo un campione di 103 osservazioni di round di investimento condotti tra VC e biotech start-up sul mercato europeo.

Esploriamo i segnali che determinano la valutazione della start-up e, in particolare, i fattori rilevanti che abbiamo identificato possono essere suddivisi in tre categorie, i quali sintetizzano le caratteristiche specifiche della start-up e del VC. Le prime due categorie

includono informazioni non finanziarie, che si riferiscono agli attributi dei fondatori (Istruzione ed Esperienza), e influenzano la valutazione dei VC essendo considerati di grande significato per gli investitori, soprattutto durante gli *early stages* (Hand, 2005). La terza categoria riguarda l'esperienza del VC, che, invece, influenza il processo di selezione degli investitori da parte della start-up. Gli imprenditori valutano gli investitori non solo sulla base della loro offerta finanziaria, ma anche sui servizi e le competenze a valore aggiunto che possono fornire alla società (Hsu, 2004).

Noi documentiamo come un membro del gruppo imprenditoriale con una formazione manageriale, abbia un effetto positivo sulla *pre-money valuation*. Inoltre, facendo riferimento all'esperienza, dimostriamo che diversi tipi di esperienza precedente hanno un impatto diverso sulla *pre-money valuation*. Quest'ultima è negativamente influenzata dalla presenza di un fondatore che abbia esperienza pregressa come manager di alto livello nello stesso settore della start-up, oppure come VC. Allo stesso modo, anche l'esperienza precedente come fondatore di una start-up in un industria differente ha un effetto negativo, mentre, al contrario, l'esperienza nello stesso settore ha un effetto positivo. Infine, l'esperienza di un VC, analizzata in termini di società investite ed età del VC, ha un effetto negativo sulla *pre-money valuation*. Nel complesso, i nostri risultati informano i ricercatori e i *policy-makers* dell'importanza delle caratteristiche non finanziarie, sia delle start-up che dei VC, nella definizione della valutazione. Inoltre, da un punto di vista teorico, è fondamentale sottolineare come distinti *signalling factors*, nella stessa categoria considerata, possano avere un impatto completamente diverso, positivo o negativo, sulla *pre-money valuation*. Per questo motivo, entrambi gli attori devono essere in grado di comunicare tra loro nel modo più accurato possibile.

Parole chiave: VC, Venture capital, Start-ups, Valuation, Pre-money, Signalling Theory

Executive summary

Our research aims to deepen the existing literature about the relationship between start-ups and venture capitalists (VCs). The focus of our study is to better understand the characteristics of both founders and VCs that may potentially affect the valuation of the VC deal.

This is a relevant topic in entrepreneurship, because it is extremely difficult to determine the accurate value of a company, while it is in its infancy stages as its success or failure remains uncertain. Therefore, in this environment strongly characterised by uncertainty, it is fundamental to provide VCs with the best tools for assessing a precise valuation. In this way, VCs are more confident in contributing to the financing process with their funds, benefitting, in turn, the start-ups' growth. In fact, start-ups are aware of the most efficient signals to offer investors in order to testify their quality. VC can drastically change the future business of the start-up, that otherwise would suffer from many difficulties in their development. Venture-backed firms grow more rapidly and flexibly than do their Non-Venture-backed firms (Hellman, 2000). They tend to uncover new investment opportunities faster, develop them quicker and more professionally (Hellman and Puri, 2000, 2002).

We focus on the pre-money valuation, which is defined as the product of the price paid per share in the financing round and the shares outstanding prior to the financing round, expressed in thousands of dollars. More generic, pre-money valuation is simply the valuation of the company as it stands before raising new capital or any additional financing (Masud, 2018).

As a primary step, we approach our work by realizing a detailed literature review around all the topics involved in our analysis. We provide a definition of VCs by EVCA (European Venture Capital Association) and a description of their internal structure. Moreover, we outline their main characteristics with particular attention to the importance that their reputation has in the valuation process. Once understood who VCs are, we illustrate how they operate. Since VCs, as investors, intervene in a very risky and critical phase of financing, a very consolidated procedure tends to be followed. This process is characterized by several steps. Among these, valuation represents the only moment in which is possible to work on quantitative data in order to understand the potential effects that the characteristics of both parties of the deal have. We describe also the post-investment phase which is correlated with the valuation. In fact, the exit strategy and the following performance of the start-up help to better understand how the VC comes up with its final valuation offer. Furthermore, the future performance of start-ups is strongly associated and dependent on the additional services that the VCs can provide. Thus, we report all the main services that have been studied in the existing literature. In this phase, it emerges that the added value is proportional to the reputation of the VC. An overview of our target market, namely the European one, is presented, including its evolution and dynamics, then it is compared with the American one.

Moving to the other actor of the deal, we follow the same descriptive model, used for VCs, by defining what a start-up is (according to Forbes, 2013) and outlining its main characteristics. The start-up is not only analysed as a single entity but as a group of individuals. Each of them possesses specific backgrounds, which directly impacts on the final valuation. The chapter 1.2 includes the effects of these characteristics, mentioning how the management team tends to change, during the development, according to external pressure of investors (Lynall, Golden and Hilmann, 2003). Within the European market, our research focuses on the biotech industry; therefore, we decide to dedicate an entire sub-chapter to the specific dynamics that characterized this sector. These dynamics mainly refer to the relationships that start-ups, in this environment, have with pharmaceutical firms, which leads commonly to alliances and acquisitions which represent the typical exit strategies of start-ups in the development process. This process begins with an embryonic stage of money collection and, similarly to the investment process of VCs, follows a precise financing cycle, that is reported in detail in chapter 1.3. Different stages involve different business actors; entrepreneurs interact with VCs when their need for money can no longer be fulfilled by their initial resources, namely founders' savings and FFF (Friends, Family and Fools), and when banks and private equity still find the firm too risky for investment. Start-up's financing cycle optimistically ends with an IPO. The involvement of external investors impacts the equity retention levels of the start-ups, leading the founders to give up part of their ownership and voting rights.

In investigating the relationship between VCs and start-ups, is crucial to introduce the signalling theory concept developed by Michael Spence (1973). It is common knowledge that information asymmetry, and consequently the risk perceived, is higher when referring to new-born businesses (Amit et al., 1998). For this reason, it is fundamental,

in order to develop our study, to understand the impact that the unequal knowledge that the two parties may have on the valuation. In fact, in case of start-ups, they are new entities in the marketplace and do not possess an observable track record that the VCs can exploit as a criterion to manage their investment decisions. For this reason, they have to base their investment decision on other signals. We analyse the different signals in a structured way, using as a support the descriptive framework developed by Kohn (2018), which conceptualizes how start-ups' valuations in the VC context are determined by a three-sided interplay of different signals: start-ups, VCs, and the external environment. The start-ups' determinants are further divided between financial statement information and non-financial information. In particular, non-financial signals can be grouped into other four sub-categories: start-up characteristics, entrepreneur and team characteristics, intellectual property and alliances. Instead, the factors related to VCs can be brought back to their type, their reputation, their value-added activities and their valuation methodologies. The latter are one of the major causes of failure in a negotiation, because, in the particular context of biotech, are usually more qualitative than quantitative, due to the absence of tangible assets. In the subchapter 1.5.2, as we do for start-ups, we report more in detail how the characteristics of VCs can work as signals for entrepreneurs, according to previous studies in the field. Finally, we did not mention the external environment in the literature review, since market, institutional and cultural factors are considered not relevant or value adding to our analysis. From the analysis of the literature, we select a field of scientific papers (Hand, 2005; Armstrong, 2006; Sievers, 2013) that investigate the interplay of start-ups' financial and non-financial information in determining the valuation. The papers reach contrasting conclusion on the role of non-financial information: in particular, Sievers argues that Hand's idea, stating that these

two types of information are substitute in valuation, is incorrect. He states that they are complementary in accessing a more accurate valuation, one enhancing the explanatory power of the other. We decide to deepen the understanding of the impact of non-financial information, controlling for the financial characteristics of the firms.

We also select a paper from Hsu (2004), which captures our attention showing how VC experience can affect the entrepreneur's decision to either accept the offer or not. In fact, it is not only the VC that select the start-up, but also the entrepreneur that chooses the VC. The value-added activities performed by VCs are not only related to the provision of financial resources, but, also, to offer them a range of services and skills among which, one of the most important, is their management expertise.

These studies focus only on one side of the deal contractor; therefore, we recognize that an important gap could be filled by conducting a study that takes into consideration both of them. Our research analyses the two sides separately by alternatively keeping fixed one of party to verify previous studies in a new context. We elaborate our research question considering an unexplored setting, which is the early-stages' pre-money valuation, in the European market of the biotech sector.

The scope is to investigate:

1. The impact of start-ups' non-financial characteristics on VC deal valuation.
2. The impact of VC firms' characteristics on VC deal valuation.

To determine the valuation, we divide the relevant factors into three categories that express the elements of the start-up and the VC. The first two categories include non-financial information that refers to the founders' characteristics, which influence VCs' valuation, respectively education and experience. The third is related to the experience

of the VC that, instead, impacts the start-up's selection process. Our scope is to primarily investigate these categories individually and, secondary, to combine education and experience in a unified analysis.

Starting from these general considerations coming from the literature, we identify specific factors that are supposed to have an impact on valuation. To validate our expectations about these factors, we translate them into three hypotheses, one for each category.

The first basic hypothesis (H1) is related to the educational background of the company team. We take into consideration the studies from Colombo and Grilli (2005) about the positive effect of a graduate education background and the major role played by managerial education in the biotech sector (Prevezer, 2001). The latter is justified by the preference of VCs for a more heterogeneous founder team (Gompers, 2006), associated with better performance of the company. We decide to investigate how heterogeneity is measured considering factors that have not been included yet in previous research and that are related to the managerial education of the founders. In particular, we expect a positive direct effect on the pre-money valuation, from the presence of a professional within the management team with an MBA or with years of education in management.

Secondly, we focus on the experience side, which attests the heterogeneity of the founders' team in a complementary way (Hambrick and Mason, 1984). Miloud (2012) certifies that the bundle of technical, industrial and managerial abilities has significant relevance for VCs. They value a new venture significantly higher if its founders have relevant industry experience, relevant managerial experience and start-up experience before they have found their current new venture. Moreover, several studies (Chatterji,

2009; Gimeno, Folta, and Cooper, 1997) explain how the previous experience of the founders in the industry, due to their acquired expertise gained in incumbent firms, may lead to a higher probability of success in the new venture (Chatterji, 2009). In our research, we argue that specific roles, covered by the founders in their previous experience, can reflect an opposite impact on valuation, thus a negative one. The idea arises from the fact that investors are more skeptic in evaluating start-ups with founders that have previous experience as chief managers in the same industry. The reason is the increased difficulty that VCs may face in trying to assign these roles to more experienced and reliable professionals. This type of replacement is unlikely to be accepted smoothly by the company (Clarysse, 2004; Cyr et al, 2000; Roure and Keeley, 1990). Therefore, we hypothesize (H2a) a negative impact of managerial experience on pre-money valuation.

The second factor selected is the presence within the company of a member with past experience as founders of start-ups. The higher chances of success of entrepreneurs with a positive founding background (Gompers, 2010; Sievers, 2013) are explained by their persistence in choosing the right industry, their predisposition to start a new venture timely and their higher attractiveness for investors. We suppose that having already founded a start-up may provide entrepreneurs with a higher valuation (H2b). We decide to investigate if the potential positive effect exists when the entrepreneur previously founded a biotech company and, in the case where the previously founded company belonged to another industry.

Finally, we select a factor that has not been specifically investigated by the literature and that indicates if one of the founders has previous experience as VC. According to us, this can suggest that the founder has a greater capacity for negotiation, a more extensive social

network in the industry and a better understanding of the characteristics of a company that have to be stressed during the pitch to positively impress investors. Following this logic, we expect a positive impact on pre-money valuation (H2c).

On the VC side, we have already mentioned the potential value adding capability provided by VCs and how they can induce the founder to accept a lower valuation (Hsu, 2004). A higher VC experience corresponds to higher value-added services, such as mentorship, supporting recruiting and management. The literature indicates that the age and the number of investments made by VCs are credible proxies for their experience (Gompers, 1996; Sorenson and Stuart, 2001). These two factors are selected expecting a negative effect on pre-money valuation (H3).

We apply a quantitative econometric analysis to verify the hypotheses presented before. The final database was constructed from four different sources: VICO 4.0, Orbis, complementary information gathered on LinkedIn and Thomson Eikon. The companies' information is related to the European market of the biotech industry and the period of investments considered is 2000 – 2015. Instead, the VCs involved in the investments are mainly European, with few exceptions. Our analysis uses the pre-money valuation, as the dependent variable, to develop four different log-linear regression models. This approach is the standard within the current studies on venture valuation (Lerner, 1994; Gompers and Lerner, 2000; Hand, 2005).

The process of filtering data and merging datasets produce a final panel of 103 observations, which refer to 72 different companies, 124 different VCs and 100 investments. We provide some preliminary insights through descriptive statistics, which focus on investments' specificities, VCs' characteristics, syndication, geographical

distance and entrepreneurs' characteristics. Then, in order to test our hypothesis, we develop four different models, three of them with the aim of investigating the effect of specific independent variables on pre-money, while the last one combines two of the previous analysis, to test their results. These independent variables are related to the education and experience of the entrepreneur and the experience of the investor. Finally, the fourth additional analysis is the combination of the variables associated with education and experience to strengthen the previous results that emerged or to discover previously undetected effects. In all the models, we control for financial information and other confounding factors, such as the age of the start-up at the year of investments, the business activity of the start-up and the companies' countries. All the variables used in the models are provided in a detailed description.

First, we have carried out a univariate analysis through t-test for the different regression variables correlated with the pre-money valuation and discuss the most relevant ones. In particular, we find an interesting effect of syndication: conversely from what we expected, the mean of valuation of VCs investing alone is higher than VCs investing in syndication. This indicates that single investors can dispose of a greater fund than syndication, contradicting one the main reasons syndications are formed. Another relevant outcome is connected to the t-test which combines pre-money and VCs' from Hong Kong and US. We find a tendency of extra-UE investors assigning greater valuations than European ones.

Regarding H1 about the impact of founders' education on valuation, we do not confirm the importance of an MBA as explanatory factor in the increase of the pre-money valuation. On the other hand, the years spent in managerial education present a positive correlation in line with our expectations. The result for MBA may be explained by

associating the founder to a person that is likely to cover a high managerial role within the company, thus interfering with the VCs' desire to introduce a well-known experienced manager. In fact, several studies (Roure and Keeley, 1990; Cyr et al, 2000) confirm that sometimes VCs prefer to personally choose and assign high managerial roles to experienced managers and not to founders.

As for H2a, the results obtained are coherent with the hypotheses formulated, showing a strong negative correlation between pre-money valuation and the presence of a founder who previously worked as top-tier manager in a biotech start-up. This enforces our idea that the existence of a renowned managerial figure, before the deal, is not seen positively by VCs.

As for H2b on the effect of founders' previous experience, the hypothesis is confirmed only for one of the factors selected. The presence of an entrepreneur with past founding experience in the biotech sector is positively correlated with pre-money valuation. Conversely, if the founder did not operate in the same sector the correlation turns out to be negative, although for a low level of significance. The theory of Becker (1975) supports us in motivating this unexpected result. He suggests that entrepreneurs coming from a different industry do not have the specific capabilities needed to succeed in the sector, in our case the biotech one, but only the generic expertise of raising a company. Therefore, VCs may not be willing to address these start-ups with a higher valuation. Moreover, our study cannot distinguish between entrepreneurs with a successful founding history and those with a negative one. This means that there is a level of ambiguity left in interpreting the results.

Finally, we find a negative correlation between founders' previous experience as VCs and pre-money valuation (H2c) with a relatively high level of significance. This is against our prediction; we try to explain this result proposing that previous experience as VC can be associated to a higher attention of the founder in signing an agreement with reputable investors, not considering as a priority the financial terms of the deal. In fact, this type of founder is much more aware of the benefits deriving from the additional services provided by VCs and how they are fundamental for start-up growth.

In the third model, we combine the elements of education and experience in a single regression model to test the robustness of our results and detect possible unexpected effects. What we obtain with this analysis, is the validation of the majority of previous findings of the first two models. The only exception refers to the previous role covered by a top-tier manager which, affected by the combination of the two categories, becomes non-significant.

Concerning H3 on the impact of VC experience on valuation, the results are in contrast with our expectation, because the number of companies the VC has invested in shows a positive correlation with pre-money valuation, even if, with a low level of significance. More interestingly, the age of the VC has a very strong positive correlation. We provide a possible explanation for this result, supposing that more experienced VCs are more likely to sign deals with the most promising start-ups. We test this theory investigating the interactive effect of VC experience and founders' biotech experience. It emerges that, only these founders manage to negotiate higher valuations, while the others do not. This test contributes in sustaining our supposition.

Even if the results of the work are consistent and some of the hypotheses formulated are confirmed, the research has some limits, which suggest interesting future research directions.

On the one hand, the database in our possession does not present sufficient completeness to develop a deeper analysis, that could embrace a higher number of observations among both companies and VCs. It conditions our methodology, both in the process of selecting variables, limiting the number of the ones available to be used and in the decision process regarding the possible relevant analyses to be carried out. On the other hand, another relevant constraint is the missing information about the founding history of the entrepreneurs and the following years of start-up development, in terms of exit. Having this information would have certainly supported us in better understanding the results regarding our hypothesis. Moreover, this study takes into account what happens in the European start-up's context, therefore, it is not possible to directly conclude that the deductions drawn from this research are valid also in other markets. Different variables may be more or less relevant due to diverse cultural contexts and to a different historical development of the VCs-start-ups ecosystem. In our work, we decide to keep constant the characteristics of one party when analysing the other because, due to the limited number of observations, we were unable to study the joint effect of the two factors. It could, therefore, be very interesting for future researchers to investigate the effect that different configurations of experience and education of the start-up's founders and experience of the VCs together, influence the pre-money valuation. The same research may be conducted varying the geographical area, the time and the industry of the sample of VCs' backed firms. Finally, future works can deepen the results that emerged from the t-tests related to the impact of external investors and syndication on pre-money.

*“The main fuel to speed the world’s progress is our stock
of knowledge, and the brake is our lack of imagination”*

Julian Lincoln Simon, Economist

Introduction

Nowadays, the economy has to profoundly rely on scientific and technological progress to continue its growth. The key to ensure the prosecution of the progress is creating a flourishing entrepreneurial ecosystem where more and more new ventures have the possibility to raise and introduce technological innovation (Geroski, 1995). A precondition to assure the survival of this habitat is the constant provision of resources to start-ups. In the case of a lack of these resources, the companies' ability to maintain operations over time may not be guaranteed. Especially, newly born companies may reduce their orientation towards innovation and may not represent an attractive job opportunity for talented employees willing to bring new ideas to the market (Praag and Versloot, 2007). Nonetheless, it is well-known that this environment, compared to the traditional entrepreneurial ecosystem, is characterized by higher risk, due to considerable information asymmetry (Amit et al., 1998). In fact, there is an unbalanced knowledge in

the relationship between start-ups and investors, where the former, due to its early age, is not capable of providing trustable data related to its business activities and future performance.

The crucial problem for high-tech entrepreneurs during the start-up phase is that their assets are mostly intangible and knowledge-based, which makes their pursuit of resources more complicated. In a business context characterized by such a high risk and uncertainty, financial actors as banks and private equity firms prefer to retain their investments. This creates a gap in the financing stage where VCs are the ones willing to fill it, with their equity capital (Markova and Petkovska-Mirčevska, 2009). Companies backed by risk capital providers contribute extremely in the regional economic development, innovation, and job creation (e.g., Collewaert, Manigart, and Aernoudt 2010; Da Rin, Nicodano, and Sembenelli 2006). Studies on the processes and decision models of venture capital have extended considerably in recent years.

Several findings have been provided on how these investors screen and choose their investment goals from a pool of opportunities offered to them (e.g., Knockaert, Clarysse, and Wright 2010; Maxwell, Jeffrey, and Lévesque 2011; Zacharakis and Shepherd 2001), on the process involving the design of deals between investors and entrepreneurs (e.g., Kaplan and Strömberg 2004; Kelly and Hay 2003), and on the development of the relationship between the entrepreneur and the VC once the agreement is reached (e.g., Mason and Harrison 1996). Nonetheless, there is a crucial part of the investment process that has been mostly avoided by the academic literature. We are talking about the valuation of the investment opportunity. There are several reasons and all of them are associated with some pragmatic complexities. In particular, the struggle to obtain reliable

data on investment deals, in terms of quotas¹ and equity, and valuations. Firm valuation, also called “pricing of the deal”, has a fundamental role for the business actors involved. On the one hand, the equity stake that VCs receive in exchange for their equity invested in the start-up comes down to the proportion of their financing compared with the start-up value. On the other hand, the equity stake belonging to the entrepreneurs is reduced after the investment, since they are left with a smaller fraction of capital in comparison with the pre-investment condition (Manigart and Meuleman 2004).

On the founders’ side, valuation is crucial as it defines the equity stake that they still have at their disposal after the deal is concluded (Vance 2005). The ownership they have and the control they can exert over the company depends on that. From VCs’ perspective, a lower valuation signifies a larger equity stake at a lower price. Accordingly, their return potential is higher, since the exit value which they extract will be greater for higher equity stakes (Manigart and Meuleman 2004). For the same reasoning, the depicted situation favours investors with higher control over the company (Cumming and Dai 2011; Hsu 2007; Mason and Harrison 2002).

If we manage to fully understand what the determinants of entrepreneurial firm valuation are, it will mean a precious improvement to simplify agreements. This study contributes to providing new insights on the topic by allowing the parties to better understand the fundamental rationale of the price-setting mechanism and give clarity to the risk capital investment system.

Previous studies on valuation in venture capital investment indicate that valuations are affected by start-up characteristics (Armstrong, Davila, and Foster 2006; Hand 2005,

¹ Quota is intended as the percentage of shares acquired by the investor through his investment

Sievers, 2013). Other researches have focused on market factors (Gompers and Lerner 2000b), and competition (Fairchild 2004; Heughebaert and Manigart 2012). Characteristics related to VCs also significantly affect start-up valuations (Cumming and Dai 2011; Hsu 2004), since founders are willing to turn down higher valuation preferring lower ones coming from more reputable investors (Hsu 2004).

We focus our study on the role played by start-up characteristics, i.e. the combination of financial and non-financial information, and by VCs characteristics. We elaborate our analysis considering the important works done by Hand (2005), Armstrong (2006) and Sievers (2013) on the start-up' side. Apart from confirming that financial information has great relevance for valuation, the first two studies propose findings on the U.S. market suggesting that non-financial information could have a smaller impact on valuation during early stages. The last research done by Sievers, on the German market, provides opposite results on the importance of non-financial information, suggesting that they have the same predictive power on future IPOs as financials and that therefore the two can be considered complementary.

Starting from these different results, we conduct further research in the field, with selected variables belonging to the human capital, namely non-financial information, of the start-ups' entrepreneurial teams. In line with the study of Hand, we take into consideration the biotech industry, but we focus on the European market. We also include financial information, namely current ratio and total assets, as control variables to develop our linear regression models. Human capital is further divided into two categories: education and experience. To study these two categories separately we develop two different models to which is added a third one conceived, instead, as the combination of the two. This last model has, in our conception, the role of further strengthening the results obtained and

discovering previously undetected effects. As mentioned above, we also enlarge the field of research to the VCs side. Taking as reference the work by Hsu, we select two independent variables associated with the experience matured by the VC firm, namely its age and number of companies that it has invested in, and create a fourth linear regression model to test its effects on valuation. In order to be able to carry out an accurate work, we decide not to excessively expand the study to all funding stages, but we choose to focus on the pre-money valuation stage.

This work aims, for the first time in this research field, to study both actors involved in the deal. In fact, this necessity emerges as evident, after many authors in the literature have repeatedly stressed how the characteristics of both actors play a fundamental role in the final valuation. We achieve this goal by developing 4 models that, alternatively, keep the characteristics of start-ups and VCs fixed or changing. For the most part, the results obtained confirm the hypotheses formulated through the study of literature and in some cases contradict the assumptions made, leaving room for a more in-depth discussion.

The following chapters are structured as follows: chapter 1 offers an extensive literature review on the topics involved, with particular attention to start-ups, VCs and the basics of signalling theory.

Chapter 2 explains in detail the research questions that motivate our work and the hypothesis that we formulate comprehensive of the assumption that led to them.

Chapter 3 illustrates the types of data and the datasets we work with and chapter 4 describes the methodology we adopted and the reasons behind.

Chapter 5 proposes in a clear and comprehensible way the results obtained from regressions and tests carried out. It also offers a discussion and further argues the results that contradict the assumptions made.

Finally, Chapter 6 is made up of 3 parts. In the first part, what has emerged in our work is summarised in the conclusion. The second part clarifies the limitations we have encountered in carrying out the work, mostly related to the data at our disposal. The third and final part ends by illustrating what we believe to be good prospects for future studies based on the results of our analysis.

Chapter 1. Literature review

1.1 Venture capital

Nowadays entrepreneurship and venture capital (VC) are global phenomena (Cumming et al., 2009). Around the world more and more countries are trying to attract start-ups because they create productivity, efficiency (by challenging the incumbent firms), and economic wealth, thus contributing to a country's overall competitiveness (Cumming et al., 2014). Thanks to these favourable conditions that have been developed, the number of start-ups is growing at a rapid pace. In recent years, we have seen dramatic growth, more than 200% of the initial number (Austin et al., 2016). The survival of start-ups depends a lot on the capital they are able to find, which is essential to run their business and accelerate their growth.

This has raised the necessity for regulators and other relevant parties to pursue a comprehensive understanding of the determinants that influence the valuations of start-ups in the VC context (Kohn, 2018). A better comprehension of these dynamics has important implications for the two main actors involved. For entrepreneurs, valuation states how many shares, and hence control, they hold in their venture after an investment, while valuation also impacts VCs' returns at the exit and in turn those of their fund investors (Cumming and Dai, 2011; Hsu, 2004; Zheng et al., 2010).

The following sections are structured as follows: in the first part a definition of VC is provided and the main characteristics are presented; then the European market, that is of interest to our research, is described; then we move on to describe the main VCs activities, dividing them into Investment and Post-Investment, the latter with a particular focus on the value-added provided by VCs. We deepen the valuation phase and finally, in the last sections, we explain the problem of information asymmetry.

1.1.1 VC definition, characteristics and the role of reputation.

VC is part of the largest private equity family focused mainly on investing in young and high-tech start-ups.

The EVCA (European Venture Capital Association) (2013) defines the VC as:

“[...] an intermediary who collects funds from a group of investors, such as banks, pension funds, insurance companies, and foundations, or has its own proprietary pool of

capital, and invests them in the equity capital of newly established and highly innovative firms”.

A VC fund is an economic initiative of limited time, usually 5 or 8 years. It can dispose of the funds consisting of the money raised from the different actors and aims at providing the highest possible return. The highest possible return allows to adequately remunerate investors and increase VC credibility to find further funds and start a new investment cycle.

Founders of a VC firm are called General Partners (GPs) and the investors they attract take the name of Limited Partners (LPs). These participations that a VC fund has can be private, public or mixed. LPs can be high net-worth individuals, family offices, foundations, big corporations, endowment funds, pension funds, or funds of funds.

Typically, a VC firm concludes 5-10 deals per year, where each investment is estimated, on average, around \$4 million. It is usually nationwide, sometimes regional and focuses on one or two industries. The group of decision-makers is composed of MBAs and professionals with an approximate age of 40-years-old. The investment horizon is usually short (3 to 5 years) with a Return on Investment expectation around 30-50% (Morrissette, 2007).

The VC Takatkah (2019), provides an example of the most used VC fund structure. The diagram (Fig. 1) allows us to better understand all the different legal entities that, combined, form the so-called VC firm.

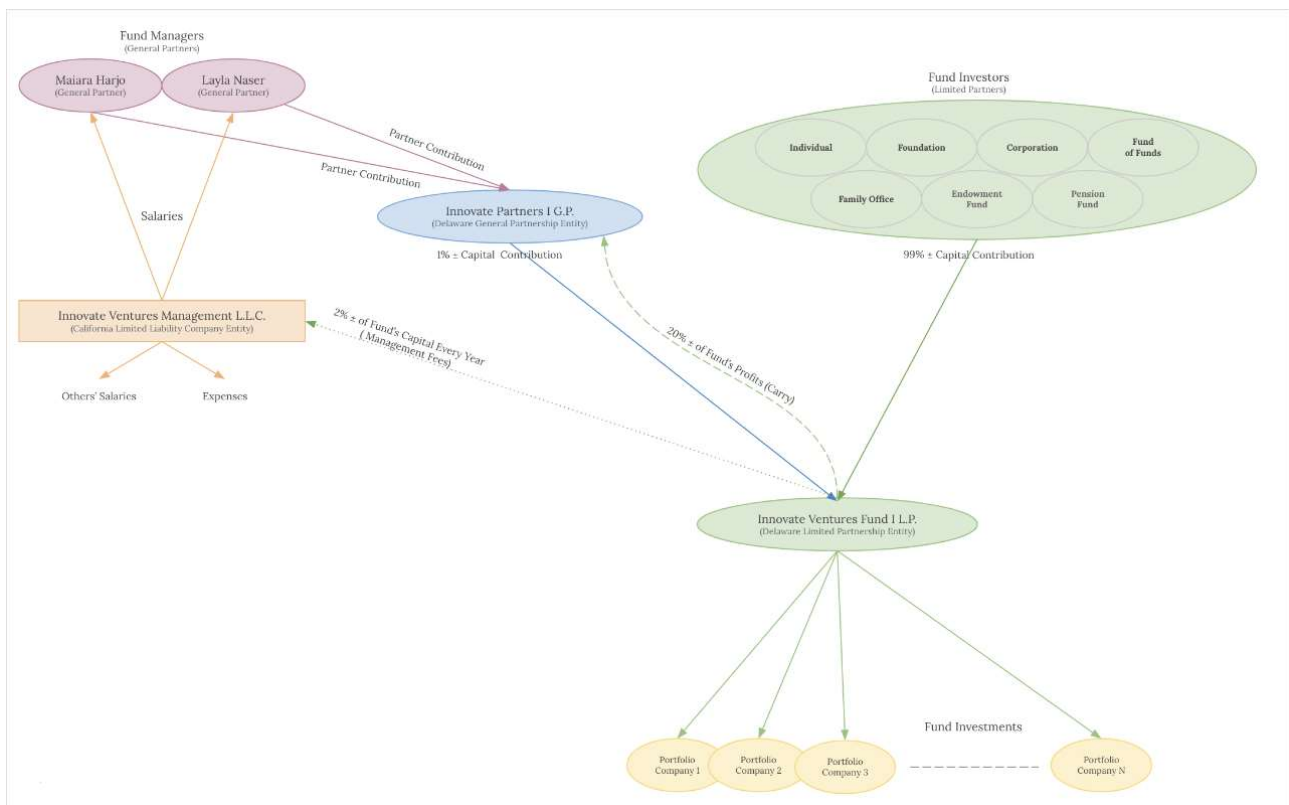


Figure 1 VC Fund Structure (Takatkah, 2019)

Above it is represented a fictional California-based VC firm: “Innovate Ventures”, started by two fictional VCs. They constitute the general partners and provide partner contributions to the fund and a small fraction of capital. Fund investors, thus the LPs, can be of various types and provide almost all the required capital (the numbers used are taken from U.S. median values). The fund creates a structured portfolio with various investments in different companies.

Around 20% of the fund’s profits are distributed among partners in the firm.

The 2% of the fund’s capital that’s compensated annually to the management firm is commonly adopted to deal with salaries and other firm expenses (excluding some fund expenditures that are usually forwarded to LPs).

VCs can also be differentiated in open or closed funds and from an investor's perspective they may be:

- Traditional: all investors invest on an equal footing;
- Asymmetric: different investors have different terms.

The crucial aspects on which the investor and any other shareholders must agree are:

- The identification of the most appropriate time to carry out the divestment;
- The definition of the most appropriate channel, as there are different ways of disinvesting.

The typical channels used by investors to dispose of their shares are:

- The sale of shares to another industrial company;
- The sale of shares to another institutional investor;
- IPO: in most cases, listing on a regulated market is the most desirable way of disposing of holdings.
- The repurchase of the shares by the original entrepreneurial group (rare case).

The phases that characterize the activity of the VCs can be summarized in deal sourcing, investment selection, valuation tools, deal structure, post-investment value add, exits, internal organization of the firms and relationships with limited partners.

VCs act on the selection process as scouts, they are able to identify promising potential and subsequently they provide support in the post-investment phase as coaches and mentors that provides help to new businesses. The topic of VCs activities is discussed in detail later in section (1.1.3). Obviously, the contribution that a VC can make varies

considerably depending on its characteristics. The studies in the sector frequently focus on the factors that characterize a start-up, however, this is true also for VCs. They have different characteristics, value-added potential and can offer several services to young companies apart from the capital.

The VCs' characteristics are highlighted by many factors that are very significant for entrepreneurs. Among the most important, the effects of experience and reputation of the VC has been the focus of many studies. They can lead to significant positive effects for the start-up and have to be considered carefully because the capacity of VCs to add value can varies considerably, to the point that some VCs can even have a negative value effect. In his studies, Hsu (2004) shows how VC reputation benefits the invested firm and how start-ups are willing to accept even a lower valuation in order to join a more reputable VC. VCs' experience, information network and direct assistance to their portfolio firms are factors that affect VC reputation (Bengtsson and Sensoy, 2011; Hsu, 2004,). Besides these factors, Gompers (1996) proposes to use the age of VC as a proxy for investor reputation. Gompers and Lerner (2004) show that younger VC firms struggle for the short formation of their reputation in the VC industry by taking their portfolio companies public sooner and under-pricing them. Every additional investment enlarges VC's information network in two possible ways: obtaining prominent social contacts and/ or gaining experience in successfully structuring contracts and/ or monitoring entrepreneurs in the industrial sector (Sorenson and Stuart, 2001). Cumming and Dai, (2011) examine the effects that fund size and VCs' limited attention have on the valuations of start-ups. The findings suggest that fund size is in general positively associated with VCs' bargaining power which allows them to get a lower price for their investments. Given that, it should

be remarked that fund size can also serve as a measure of VCs' quality, and thus their reputation (Bengtsson and Sensoy, 2011, Kaplan and Schoar, 2005).

Lerner (1994a) found that experienced VCs seem to be particularly capable of taking companies public near market peaks. Hochberg, Ljungqvist, and Lu (2007) show how the probability of profitable exits can be increased by VCs with a broader network for their portfolio companies. Sørensen (2007) documents the more experienced VCs, through their funds, help the start-ups to have better chances of going public primarily due to their ability to source better investments. Nahata (2008) provides evidence that companies backed by VCs with higher reputations are more likely to exit successfully, access public markets sooner, and have higher asset productivity at IPOs. Moreover, the research from Krishnan, Masulis, Ivanov, and Singh (2011) finds that the support of more experienced VCs affects companies as they have better post-issuance performance and better-quality corporate governance. Studies have also shown that entrepreneurs are aware of the benefits associated with VC reputation.

According to Hsu (2004), entrepreneurs select offers among competing VC investors not only based on the financial terms but more often by considering the reputation of the VC investors. Entrepreneurs with multiple financing proposals are more willing to turn down the best financial offers from less reputable VCs and agree for strict financial conditions from more reputable VCs. He proved in his research as offers made by VCs with a high reputation are three times more expected to be accepted, and high-reputation VCs obtain start-up equity at a 10–14% discount. These results are confirmed also in the later work of Falik et al. (2016). Since association with high reputation VCs means performance benefits, such affiliation cannot be freely obtained, conversely, certification agents would not be interested to invest in gaining a reputation in the first place (Shapiro, 1983). Prices

offered by VCs to entrepreneurs in order to get start-up equity reflect the market for affiliation. Furthermore, the price that VCs pay to obtain start-up equity is relevant for both entrepreneurs and VCs (Hsu, 2004). Once the deal has been established, it is argued that the stake that remains in possession of the entrepreneur is way more valuable ex post due to the value-added services provided by the VC.

1.1.2 Venture capital Investment Process

As said earlier, the phases that characterize the activities of the VCs can be summarized and divided into Investment Selection (deal sourcing or origination, investment screening, valuation tools, deal structure) and Post-Investment (value add, exits, internal organization of the firms and relationships with limited partners) (Kollmann and Kuckertz, 2010; Petty and Gruber, 2011).

In this section, we describe in detail the steps that constitute the investment process, whereas, in the next section, we illustrate the phases of the post-investment process.

Deal sourcing is the initial part of the investment and refers to the process by which VCs engage entrepreneurs and screen through the potential opportunities presented to make an investment decision. The research made by Gompers, Gornall, Kaplan and Strebulaev (2016) analyses how the steps taken by the VCs are characterized throughout the process. The table below (Fig. 2) shows how most of the deals come from the VCs' networks.

VCs Deal Flow Sources		
Sources	Early Stage Percentage (%)	Late Stage Percentage (%)
Generated through professional network	31	25
Proactively self-generated	23	42
Referred by other investors	22	17
Inbound from company management	12	7
Referred by portfolio company	9	4
Quantitative sourcing	1	3

Figure 2 VCs deal flow by sources (Gompers et al, 2016)

Once a company is considered at the top of the funnel, the selection process usually looks like the graphic below (Fig. 3).

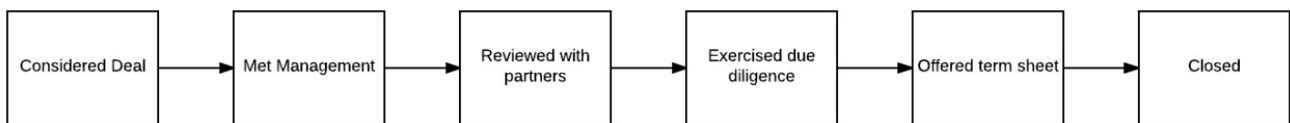


Figure 3 Selection process (Gompers et al, 2016)

VC investment is mostly characterized by the following elements:

- Development phase, investments in particularly promising business ideas and start-up companies often in the pre-revenue phase;
- Technological content, investments in industries with high innovation content;
- High-risk component, since VCs invest mainly in companies that are characterized by a high level of risk both at an operational and financial level. This means that there is no certainty of having a market for its products/ services

and that the possibility of not being able to recover the invested capital is very high;

- VC investments in start-ups are made in most cases in the form of illiquid preferred stock.

When choosing an investment, the three aspects that have the greatest impact are:

- A solid and competent team; importance relevance of characters and capacity of the team, where the latter ensures that the team possesses all the capabilities needed;
- A very large reference market, where the company’s financial outlook can show significant profitability;
- A product/ service that already has a competitive advantage; the product should represent an innovative idea, provide communal benefit and long-term sustainability.

Important Factors for Investment Selection		
Most Important Factor	Early Stage Percentage (%)	Late Stage Percentage (%)
Team	53	39
Business Model	7	19
Product/Technology	12	8
Market	7	11
Industry	6	4
Valuation	0	3
Ability to add value	2	2
Fit with the fund	13	13

Figure 4 Important factors for investment selection (Gompers et al, 2016)

Venture capital investors usually are into one specific investment stage. Each round also has its own particular set of parameters classified according to:

- Operational progress that future investment is required to demonstrate;
- The extent of capital a fund may invest in a certain venture;
- Investment time horizon, thus the time period from when the investor provides the funds to when he gets back profits;
- Investor return expectations, thus the portion of profits generated by the company that will satisfy the investor's requirements.

In the entrepreneurial context, financial intermediaries, such as VC companies, play a fundamental role in the selection process. Even though only 0.25% of companies receive venture financing, VCs strongly condition the environment in which these new companies grow (Baum, 2004).

Afterward, in the deal structure phase, VC realize contracts to guarantee that the entrepreneur performs in the best way possible and, if this does not happen, to protect himself by forcing the entrepreneurs to cede control to the investors. In this context, a significant element of VCs deal structure is syndication. Syndicates are a kind of inter-organizational co-operation which has the role of financial intermediation, in the same way as individual VC firms work. VCs syndicate around 65% of their investments to reduce capital necessities, share risks, build reputation and gain complementary expertise. These factors are taken into consideration by VCs when choosing a partnership with other VCs in deals (Gompers et al, 2016).

Important Factors when Choosing Syndicate Partners		
Most Important Factor	Early Stage Percentage (%)	Late Stage Percentage (%)
Expertise	26	20
Past shared success	29	32
Reputation	14	21
Track record	15	21
Capital	10	3
Geography	2	0
Social Connections	2	0

Figure 5 Important factors when choosing Syndicate Partners (Gompers et al, 2016)

The traditional components of contract design are information and agency problems and the quality of a legal institution. Moreover, it emerges also that geographical and cultural elements can form an essential component. Bengtsson and David (2009) find that, in the Californian market, contracts include fewer cash flow contingencies when the geographical distance between VC and company is shorter. This finding supports the perspective that monitoring and soft information decrease with distance but can be replaced with high-powered incentive contracts.

1.1.3 Post-Investment: Venture Capital value-added and exit

Once the deal structure phase of the investment process is reached, the concern for the assessment of the management team and the feasibility of the business concept decreases, while emphasis is placed on the ability of the start-up to convert the business concept into

sales and profits, which are fundamental for the VC's financial valuation of the start-up (Kollmann and Kuckertz, 2010).

This can be achieved by adding value to the start-up. VCs also act on the start-up development process by providing financial resources and benefiting the companies that have adopted or will adopt, particular strategies suggested by them (Baum, 2004). The VCs can also offer companies a range of skills, among which one of the most important is their management expertise. It represents a serious boost for the professionalization of start-ups (Hellman and Puri, 2002): they can progress governance through strategic guidance, a more structured board of directors and an important help in finding new managers and directors on the market (Gompers et al, 2016). This mentoring has the aim to increase the chances of success of the start-up in which they invest (Hellmann and Puri, 2002). The services offered by VCs include business recommendations, extensive mentoring, financial support, striking strategic alliances and recruiting senior executive managers (Gorman and Sahlman 1989; Hellman and Puri, 2002; MacMillan et al. 1989; Stuart et al. 1999). VCs are looking for financial returns, which can be obtained in various ways such as joining the product market competition, licensing, or achieving partnerships with prominent firms through alliances or acquisitions (Baum and Silverman, 2004; Gans et al., 2002).

Moreover, VCs can contribute also in the later stages of start-up development in many ways such as assembling additional funds or achieving liquidity. This contribution may involve hiring talented investment bankers (Barry et al., 1990; Megginson and Weiss, 1991) or in locating merger or acquisition partners (Gans, Hsu, and Stern, 2002).

These extra-financial services can have financial consequences and can particularly benefit early-stage start-ups (Roberts, 1991).

VCs Value Add Activities		
Activities	Early Stage Percentage (%)	Late Stage Percentage (%)
Hire board members	55	60
Hire employees	51	41
Connect customers	69	67
Connect investors	81	58
Strategic guidance	86	88
Operational guidance	65	62
Other (liquidity events guidance, mentoring, fund raising, product development, board governance)	19	17

Figure 6 Activities in Portfolio Companies (Gompers et al, 2016)

Several studies (Sorensen, 2007; Kaplan and Schoar, 2005; Gompers, Kovner, Lerner J, Scharfstein D, 2010) have shown that companies that were funded by highly experienced VC firms (top tiers) were more likely to succeed. This can be explained both by a higher capacity of top-tier VC firms in identifying high-quality companies and entrepreneurs and by their additional values. In any case, significant lower start-up performances only exist when VC firms invest in companies that were founded by entrepreneurs at their first experience or have previously failed (Gompers, 2010).

The data indicate that VCs' "extra-financial" value can create more distinction than financial capital. VC certification value and the value-added services they provide have led researches in the descriptive literature to state:

“It is far more important whose money you get [as an entrepreneur] than how much you get or how much you pay for it” (Bygrave and Timmons, 1992, p. 208) and “From whom you raise capital is often more important than the terms” (Sahlman, 1997, p. 107).

At the end of the relationship between VC and the company, the investments convert into liquid common stock or cash only later on in two possible events, identified as exit points: an IPO, or the sale of the company (Hand, 2007).

The divestment, therefore, consists of selling all or part of the investor's holding, which, in some cases, may even decide to retain a minimum share of the capital in the company on a more permanent basis. Since it is precisely in this phase that the capital gain is realized, disinvestment is a very delicate phase for the institutional investor.

1.1.4 VC Valuation

The VCs valuation is the topic that holds more importance in the studies that have been done so far on the relationship between VCs and start-ups and, consequently, also for our research. As seen partially in other sections, many factors determine the final valuation, both from the investors' and the entrepreneurs' side. Knowing more about how these factors relate to each other is crucial to understand this relatively young and highly dynamic economic environment.

The valuation criteria used by VCs and their importance vary during the investment process (Petty and Gruber, 2011) and consist of the entrepreneur's experience and personality, product and business model characteristics, market and financial characteristics of the company (Franke et al., 2006; Ge et al., 2005; Macmillan et al.,

1985; Zacharakis and Meyer, 2000). One of the factors that help start-ups receiving a greater valuation by VCs is the identification of clear business objectives (Block, 2014). Silva (2004) analyses VCs' (VCs) decision-making and discovers that their attention is directed to the entrepreneur, the business idea, its sustainable advantages and growth potential. As shown in his research, financial forecasts do not have a major role in the selection of early-phase projects. An analysis of the characteristics of the industry, including intensity of rivalry, entry and exit barriers, and characteristics of the firm, such as its development stage and competitiveness, shows that those are considered as more qualitative rather than quantitative factors in significantly influencing firm's valuation (Miloud, 2012).

Previous researches show that marketing investments are significantly relevant for the success of early-stage entrepreneurial ventures (Gruber, 2004; Hills, 1984; Kraus et al., 2011). Studies on VC financing decisions brought evidence that supports this claim by demonstrating a start-up's market orientation is considered a fundamental investment criterion by VCs (Douglas and Shepherd, 2002; Hills, 1984; Hisrich, 1989; Wortman et al., 1989). One way to document one's market orientation is to compile trademarks, even before the same trademark assets have been developed (Block, 2014). Nonetheless, a small fraction of empirical studies has studied the real influence of entrepreneurial marketing actions on VC financing decisions (Gruber, 2004; Kraus et al., 2011).

Investments have a high degree of uncertainty; thus, it is not surprising that most VCs don't really adopt financial techniques such as DCFs or NPV to evaluate their investments.

Early-stage VCs are more likely to set the valuation using investment amounts and target ownership. On the contrary, late-stage VCs can use more sophisticated methods to get to the company valuation.

Kollmann and Kuckertz (2010) found that valuation uncertainties related to certain valuation criteria change throughout the investment process. For instance, in the early stages of the investment process, criteria concerning start-up's management are uncertain, while in the following phases of the investment process, the financial valuation of start-ups is surrounded by uncertainty associated with market acceptance and profitability.

Former studies found valuation criteria such as the start-up's network and alliance capital, potential patent applications, and the venture concept are used by VCs during the process of establishing financial value (e.g., Baum and Silverman, 2004; Ge et al., 2005; Hall and Hofer, 1993; Hsu, 2007; Miloud et al., 2012).

1.1.5 VC market in Europe

The European VC market needs to bridge an initial gap with the US market, which was originated earlier (from the 60s) and is characterized by a higher pace. The EU along the years has come to understand the importance of a well-functioning capital markets union but still remains underdeveloped. In 2016, VCs invested about €6.5 billion in the EU compared to €39.4 billion in the US. Moreover, VC funds in Europe are too small – €56 million on average compared to €156 million in the US. This contrast is evident considering that the population of Europe (EU28) is 500 million, much greater than the

US population of 364 million and that the two have comparable levels of GDP per capita. Considered its relatively low ratio of VC investment in start-ups to GDP, European VC investment could increase fourfold or fivefold before reaching the levels in the U.S (Miralles, 2019). As a result, these companies move to ecosystems where they have better chances to grow fast (European Commission, 2019). The presence and accessibility of alternative funding paths (e.g. VC and BA) are also underdeveloped for SMEs, having European companies over-reliant on bank funding (AFME and BCG, 2015). Furthermore, the VC setting in Europe is characterized by significant fragmentation across national borders, not to mention the frequent problem of double taxation (Kraemer-Eis, 2016). An Unquote Intelligence (2006) survey discovered that “public money remains absolutely critical to the European venture industry and is likely to remain so for the next five years”, and this is particularly true for first-time funding, while the same can be said only for practically half of private investors. However, there is also some good news coming from the data related to 2018 released by Pitchbook. For the very first time, VC funding in Europe overcame €20 billion, which was made possible by an increase of deal sizes and valuations. This result was achieved despite a sensible drop in the number of transactions, some 25.9% YoY, especially in the earliest stages (Hodgson, 2019). Moreover, the European Investment Fund (EIF) released data that show with evidence that Europe has seen significant growth in VC investment and fundraising. VC investments in start-ups have grown fourfold to €23billions in the last 5 years (2013 to 2018). VC fundraising has doubled to €9.9billions in the last 3 years (2015 to 2017) (Miralles, 2019).

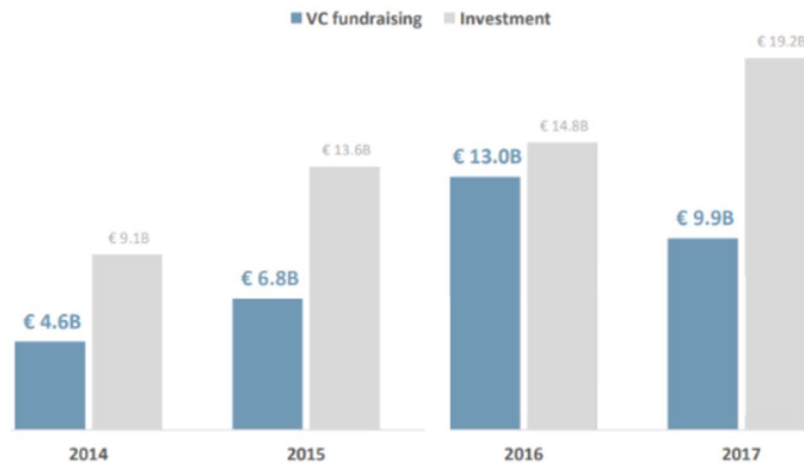


Figure 7 Acceleration of VC investment and fundraising (Miralles, 2019)

More than half of European firms have been active for over 12 years, meaning there are now plenty of experienced fund managers who have seen multiple cycles and developed track records and sector-specific knowledge. This provides investors with more funding opportunities than 10 years ago (Marovac, 2017). The year 2018 was characterized by a different trend than in previous years. The uptick in deal size was not driven by a few blockbuster transactions, but rather an increase in capital invested across all kinds of transactions. At the same time, corporate VC's incidence in European deals grew in bigger rounds, increasing their importance as sources of capital for start-ups. However, corporate investors do not have a similar significant presence in smaller deals. There is a registered 25.8% reduction in angel and seed rounds, and a 19.1% drop in early-stage deals from 2017 (Hodgson, 2019).

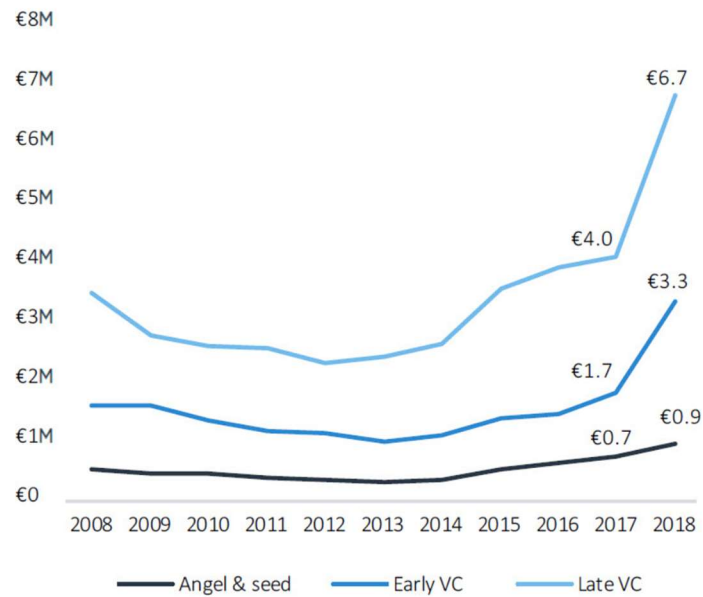


Figure 8 Record highs in deal sizes (Hodgson 2019)

The dominant start-up market in Europe is the UK, with 37% of the total shares, followed by France, Germany, Spain, and Sweden. UK dominance is due to:

1. The country is the financial centre of Europe (despite Brexit);
2. The quality and size of its start-up eco-system, including incubators, accelerators, business angels, bankers in tech, M&A advisors in tech, and the number and size of the VC funds too;
3. UK VC managers can work with longer track records that allow a more accurate valuation (Miralles, 2019).

It should also be stressed that the importance that entrepreneurs themselves attach to valuation is different also considering their geographical origin. This shows that the discordant results found in this area are influenced by cultural differences. An example of this trend is the research carried out by Valliere and Peterson (2007), who found that regardless of their experience, entrepreneurs from the USA, Canada, and the UK put the

valuation at the top of the criteria for accepting an investment deal. Equally noteworthy, Manigart et al. (1997) found that VCs' levels of required returns differ across countries. For instance, UK investors require higher returns than their colleagues from France, whereas Belgian and Dutch VCs request the lowest returns of the sample. This suggests that, theoretically, it would be in the interest of UK VCs to grant lower valuations to start-ups than their counterparts from France, Belgium and Holland.

1.2 Start-up

In this chapter, we outline the general characteristics of start-ups and we also provide specific knowledge strictly related with our research. The section is divided according to sub-chapters that describe: start-ups and entrepreneurs characteristics, the management team, the European biotech market for start-ups and the start-up funding process. More in detail, the management team sub-chapter deepens the theories of the organizational lifecycle, the board formation and its composition persistence. Lastly, the sub-chapter about European biotech market, apart from a general overview, includes also the main topics of alliances between companies and the relationship that connects pharmaceutical companies with biotech ones.

1.2.1 Start-up definition and characteristics

Start-up represents the earliest stage when an entrepreneur has the concept or idea and a team of people willing to work on it to develop a marketable product.

Generally, we identify as a “Start-up” a young and innovative venture. The concept is constantly evolving and, for this reason, we cannot refer to a single definition for the term. Since the beginning of the studies on the subject, different definitions have followed. They added and highlighted different aspects of the concept of start-ups.

We consider it useful to report a definition advanced by Forbes in 2013 in which entrepreneurs, founders and economists participate with definitions and considerations. According to this definition, some features that define a start-up as such are listed. They are:

- Far from IPO (Initial Public Offering);
- Up to 3-5 years old;
- A single office;
- Independent company
- Less than 80 employees and less than 5 people on the board;
- High ability to achieve unconstrained grow;
- Revenues lower than 20 million \$;
- Founders who haven't personally sold shares yet.

In any case, it is necessary to point out the fact that these limits that have been identified to outline in the concept of start-ups are not shared by everyone in the sector.

European Start-up Monitor achieves a different, less detailed definition. He does it starting from the words of Steve Blank, an entrepreneur from Silicon Valley, for whom a start-up is “an organization built to search for a repeatable and scalable business model”.

Through these considerations, the characteristics that are conferred to the start-up are:

- Start-ups are younger than 10 years;
- Start-ups feature (highly) innovative technologies and/ or business models;
- Start-ups have (strive for) significant employee and/ or sales growth.

It is proven that start-ups have a fundamental role in creating new jobs. Besides, they also promote new ideas within the market. Furthermore, there is an optimistic view that sees an increasing role of entrepreneurship in creating innovative activities (Acs et al., 2005).

1.2.2 Entrepreneurs' characteristics

Nowadays entrepreneurship keeps evolving its model thanks to the variation generated from the founding of new firms, the pursue of new strategies and the attempt to mix different sets of assets (Baum, 2004).

The entrepreneur's characteristics may have influences on the choices made by the start-up (Cassar, 2004). These traits of the entrepreneur can have the value of signals associated with the viability of the company, the predisposition of the entrepreneur towards risk and

his desire for control. Finally, the potential exposure of the entrepreneur to financial discrimination or network resources must also be considered (Bates, 1991, 1997; Haynes and Haynes, 1999; Coleman, 2000).

The characteristics of the owner influence different aspects of start-ups such as its capital structure and its financing (Cassar, 2004). They can also serve as a signal. In particular, the levels of education and experience can offer signs of a better human capital that, in turn, means better access to debt capital. (Storey, 1994; Bates, 1997).

The same gender of the decision-maker influences as it can represent implications in the capital structure and in the financing due to different discriminations of credit, risk aversion or the fact that the gender of this role determines different levels of capital (Coleman and Cohn, 2000). As for the age of the owner, it was found that this is negatively related to leverage, while it is positively related to the ownership experience (Scherr et al., 1993).

Other studies that attempt to reconnect the effects of some factors on leverage, gender and years of experience (Coleman Cohn, 2000) have not been confirmed. The same lack of evidence exists on a possible relationship between gender and the probability of obtaining a type of loan (Storey, 1994; Coleman, 1998; Verheul and Thurik, 2001).

Hsu (2004a) provides consistent data proving that serial entrepreneurs get outside funding in a shorter time than first-time entrepreneurs thanks to their prior experience that helps them reduce the uncertainty VCs face during the funding decision. In one of his subsequent work (2007), the author finds that prior founding experience (especially financially successful experience) increases both the likelihood of VC funding via a direct tie and venture valuation.

Another advantage that entrepreneurs with successful pasts can count on is that they have a greater chance of being successful than first-time entrepreneurs and those who have already taken them up previously. The entrepreneurs with a series of successes behind them show a certain persistence in choosing the right industry and a predisposition in the timing to start a new venture (Gompers, 2010).

According to Gompers (2010), entrepreneurs who show that they have market timing among their characteristics are also more likely to achieve better results than their industry peers in the following ventures. The perception of a certain persistence in performance, or the conviction that an entrepreneur who has previously obtained several successes possesses higher qualities than one who has encountered failures in the past, can itself induce real performance persistence. As proof of this, the industry-year success rate in the first venture is considered the best predictor of success in future ventures.

Another important characteristic that differentiates entrepreneurs is the extension of their social network. One of the first studies in the field comes from Dubini and Aldrich (1991) that highlight the role of external ties in understanding the beginning, growth and expansion of new ventures. If the network of entrepreneurs is highly developed, the ease with which a new business will start and grow will be greater. Stuart, Hoang and Hybles (1999) argue that this network is the key to reaching new opportunities, acquiring resources and gaining legitimacy. Consequently, as claimed by Uzzi (1996), when the opportunity is identified, the entrepreneur, by the means of his network, can proceed to exploit it thanks to the access to resources obtained, often at a lower cost than the open market. Finally, the presence of strategic partners, such as VCs, or in general other credible business companies, is always positively associated with a company's valuation (Miloud, 2012).

1.2.3 Start-up Management Team

In this chapter, we want to deepen the topic of the management team of the start-up. The information we provide is attained principally by the paper of Lynall, Golden, and Hilmann (2003). The study, starting from general considerations about the whole world of companies, focuses its attention on the new ventures' environment.

The management team is suggested to be a potential reason for the contrast between the founders and the VC since the actors can reflect a different conception of team composition. According to this logic, the management team is argued to indicate the balance power between the founder and the financier. This relationship has a strong consequence on the team's final development (Lynall et al, 2003). Furthermore, the chapter aims to show the reasons why, as the company develops, it is increasingly difficult to change the management team, that tends to become self-referential and lower the overall performances of the company. From these considerations, it is logical to assume that VCs have urgency and willingness to intervene personally modifying the management team of the start-up before this is no longer possible.

THE ORGANIZATIONAL LIFE CYCLE

The Organizational Life Cycle represents the process during which the company's stage of development outlines its behaviour. One of the first authors to face this topic has been Chandler (1962). He studied how the company's strategy and structure adapt according to the different phases of development. Then, several researchers analysed a range of

organizational variables including the criteria utilized to evaluate the effectiveness (Quinn and Cameron, 1983); the problems considered as crucial by managers (Kazanjian, 1988); the priorities of top management (Smith, Mitchell, and Summer, 1985); organizational methods adopted by human resources (Milliman, Von Glionw, and Nathan, 1991); and the relative prominence of stakeholders during any single phase of the life cycle (Jawahar and McLaughlin, 2001)

Among the most cited variations across the life cycle phases are transforming resource needs, increasing complexity of systems, structures and managerial competencies (Jawahar and McLaughlin, 2001). The most adopted model is the one of Quinn and Cameron's (1983); a standard based on nine different, but empirically supported sub-models.

This is composed by a four-stage life cycle:

1. Entrepreneurial (early innovation, niche development, creativity);
2. Collectivity (strong cohesion, commitment);
3. Formalization and control (solidity and institutionalization);
4. Structure elaboration and adaptation (domain enlargement and decentralization).

We focus our attention on the entrepreneurial stage, associated with a time during which the organization is looking for obtaining a survival threshold (Quinn and Cameron, 1983). The decision making is characterised mainly by real-time decisions since the management team tends to react more to instant marketplace feedback than planned moves (Greiner, 1972). Numerous life cycle studies (Greiner, 1972; Katz and Kahn, 1979; Quinn and Cameron, 1983; Scott, 1971) indicate that transitions to different managerial and organizational structures (e.g., enhanced delegation of authority, centralization of

administration, implementation of functional configurations) are linked with the inability of the present systems to handle the complexities related to the firm expansion and development. Overall, those studies propose that board composition might vary according to the stage of the life cycle.

BOARD FORMATION

The board can be established in different phases of the firm's growth. It frequently happens that the crucial period when an accountable board is formed is the one preceding an initial public offering (IPO). This is also the moment that leads to the institution of a formalized governance structure (Fama, 1980; Fama and Jensen, 1983) The introduction of recognised managers into the financial, strategic and operational affairs of the company can turn out to be extremely valuable. Nonetheless, it usually represents a conflicting action. The partition of ownership and management, even just the dilution of ownership, means an exchange of power from the founder to external financiers (Lynall et al, 2003).

Finkelstein (1992) presents various dimensions of power (structural, ownership, expert, and prestige) and all of them contribute to influence the formation of the board.

Structural is related to formal organization structure and hierarchical authority; ownership power indicates the position in the principal-agent bond; expert power reflects the ability to manage environmental eventualities; lastly, prestige power is connected with the reputation held in the institutional environment and among stakeholders. Nonetheless, it is fundamental to remark that the company's legitimacy is affected also by the prestige of its managers (D'Aveni, 1990).

Specific factors that can be positively linked to the power of prestige, are mentioned. An example of this is the position of a CEO in the “management elite” or the reputation of an investor in the financial community. These are considered indicators of value and the ability to leverage your social network to recruit the most capable board members.

In the setting of a pre-existing non-externally accountable (i.e., advisory) board, CEO control during the governing board formation is suggested to lead to continuity in membership. Conversely, investor dominance could bring to a board re-composition as the investor pursues an alignment of the board with its interests.

Commonly, the start-up organizes itself during the early stages by adding management capabilities and developing strategic alliances. This is done in the perspective of facing the uncertainty of the business and the industry.

PERSISTENCE OF BOARD COMPOSITION

One of the most intriguing theories around the management team is the persistence of the board composition. This theory suggests that the board may be characterised by a path dependency (Romanelli and Tushman, 1994). As proposed above, board composition is the outcome of both the relative power of the founder/ financier in the moment of founding and the distinctive pressures during the phase of the organizational life cycle within which it is developed.

The company often shows resistance in taking measures to adopt alternative board structures. This impediment arises from the causally ambiguous relationship between the

board's implementation of its role and the performance of the company. The explanation to that involves the lack of compelling feedback that links manager's performance to sub-optimal outcomes of the venture (Lynall et al, 2003).

Boards and their members, like management, may also be subject to image enhancement behaviours (Feldman and March, 1981; Golden, 1992). Because radical changes may publicly signal that current board composition is ineffective, only incremental changes in board characteristics and processes are likely.

This situation enhances the "stickiness" of the team characteristics, so its heterogeneity, and is even strengthened by the delayed replacement of members (Hillman, et al., 2000) as well as homophilic propensities. Homophilic selection (Lazarsfeld and Merton, 1954), the predisposition to choose and relate with similar, is likely to lead in an even more stressed entrenchment of team characteristics.

The bundle of dynamics associated with the management team formation sticks the team's commitment to previously adopted decisions and strategies, the conservation of rules, procedures, and conducts. Lastly, the homophilic selection of members contributes in aborting any possible major shift in the control of the firm coming from the founders.

The VC's favoured management team possesses an investor perspective, competences and expertise valued by the financiers (e.g., governance/ monitoring) and is inclined to endorse their position and so outperform the previous member in this role (Lynall et al, 2003).

1.2.4 Start-up in the biotech industry

Our study is based on an analysis of the information collected in the VICO database on numerous biotech start-ups on the European scene.

Biotechnology, often shortened to biotech, is the area of biology that uses living processes, organisms or systems to manufacture products or technology intended to improve the quality of human life and to perform specific industrial or manufacturing processes. Depending on the technology, tools and applications involved, biotechnology can overlap with molecular biology, bionics, bioengineering, genetic engineering and nanotechnology (Rouse, 2019).

Biotech companies usually reflect the characteristics of New Technology Based Firms (NTBF). NTBF have been defined for the first time by Arthur D. Little Group (1977), that, in a report, defined an NTBF as having the following characteristics:

- Younger than 25 years;
- Business based on potential invention or with substantial technological risks over and above those of a normal business;
- Established by a group of individuals and not a subsidiary of an established company;
- Company with the purpose of exploiting an invention or technological innovation.

In the biotech industry, companies have to deal with a long and uncertain value chain, which can reach 10-15 years from the date of the foundation through patenting to full approval by the Food and Drugs Association (FDA) and the resulting product sales.

Biotech firms are highly dependent on the intellectual property (ideas, discoveries, patents) that they generate through their large R&D expenditures, and, as such, are among the most intangible-intensive of businesses.

The standard competitive model in which these companies operate requires a young biotech start-up to participate in a fierce R&D race against competitors to develop a drug as quickly as possible. This involves using a considerable amount of capital for a prolonged period of time. In the early stages of company development, capital shortfalls are filled by VC and pharmaceutical companies that invest in strategic equity. Subsequently, it happens frequently that the capital required can be obtained exclusively through an IPO or a buyout by a huge pharmaceutical company. Considering what has been said, successful biotech firms tend to go public fairly quickly (Hand, 2004).

Higgins and Gulati (2003) describe as in the biotech industry, young firms establish their legitimacy through associations with prestigious scientists, hiring top managers from incumbent firms, or by partnering with pharmaceutical companies downstream. As discussed in Stuart et al. (1999), these inter-organizational endorsements will reduce the uncertainty surrounding young firms and allow third parties to make more informed judgments about new ventures.

Biotech firms are a significant number in the market and have large technology-oriented growth opportunities. Their rapid growth capabilities in the pre-IPO phase are extensive, especially in the case of options relative to assets-in-place (Hand, 2004). This is due to the endogenous relations between growth options, optimal investment actions and expected equity returns, where firm size and book-to-market emerge as sufficient statistics for the aggregate risk of a firm's assets-in-place (Berk et al. 1999). Equity

returns along financing rounds (round-to-round returns) are negatively related to firm size and positively related to book-to-market ratios. Fama and French (1993) more specifically claim that pre-IPO biotech firms that are small and/ or have high book-to-market ratios will earn high returns. Hand (2004) provides further information on pre-IPO biotech firms, specifying that, along with high returns between successive financing rounds they also have very low book-to-market ratios. In addition, a characteristic of pre-IPO biotech firms is to be financed by VC funds whose general partners are sophisticated and experienced businesspeople.

ALLIANCE AS A STRATEGY

Alliances with industries operating in adjacent sectors and, very often with much greater resources, are both an important signal that start-ups can send to potential investors and also represent an excellent way to achieve superior operational and development capabilities. Finally, they represent an opportunity to significantly increase the speed of business development. Biotech firms alliances with important third-party organizations, such as universities, have been shown to positively enhance their performance (Baum et al., 2000; Baum and Silverman, 2004; Bonardo et al., 2011; Gulati and Higgins, 2003; Khoury et al., 2013; Pollock and Gulati, 2007; Pollock et al., 2010; Stuart et al., 1999).

Affiliation with a prestigious university provides biotech companies with several advantages. These include, for example, the possibility of being able to access to scientific knowledge and resources (e.g., labs) of superior quality. More accurately, the effect of the affiliation with a prestigious university on investors can be analysed as a “pure”

signalling effect (Spence, 1973). In these settings, the literature has studied specific signals, many of them already reported here, such as the affiliations of firms' upper echelons with well-known companies (Chen et al., 2008; Gulati and Higgins, 2003) or their scientific standing (Deeds et al., 1997, 2004; Hess and Rothaermel, 2011; Higgins et al., 2011), and the creation of alliances with prominent third-party organizations (Baum et al., 2000; Baum and Silverman, 2004; Gulati and Higgins, 2003; Pollock and Gulati, 2007; Pollock et al., 2010; Stuart et al., 1999).

Stuart et al. (1999) found that biotech firms that form networks of equity governed partnerships with prominent large firms exhibit a shorter transition to IPO and earn greater valuations at IPO than firms without such networks. Baum et al. (2000), also analysing the biotech industry, founded that alliance network efficiency (partner diversity) positively affects revenue growth and R&D spending. In the same way, Rothaermel and Deeds (2006) conducted their research on 2,226 R&D alliances by 325 global biotechnology firms and discovered that an increase in the number of R&D alliances is positively related to new product development.

BIOTECH AND PHARMACEUTICAL FIRMS

Biotech IPO alliances are made mostly with large pharmaceutical companies. The process is carried out in the way that the IPO firm relinquishes equity in exchange for research and marketing support. The risk here is represented by the fact that issuers transfer too much value to alliance partners (Hand, 2005).

Nicholson (2005) highlights the differences between companies in the pharmaceutical and biotech industries. In the biotech industry, the main focus is on technologies that allow the discovery of new drugs, relying on microbiology and genomics. Traditional pharmaceutical companies are characterized by superior expertise in chemistry that allows them to develop new drugs from the lead compounds generated by drug discovery. Pharmaceutical companies are the longest-established players in the industry. They are usually larger and more experienced; market conditions often allow them to exploit economies of scale and scope in conducting clinical trials for safety and efficacy. They navigate the Food and Drug Administration (FDA) approval process, manufacturing, and marketing and sales. So, a possible biotech-pharmaceutical alliance could represent a way in which firms exchange services, given their different skills and expertise. The advantages, according to Nicholson (2005), lie in the fact that inexperienced biotech companies can obtain substantially discounted payments when forming their first alliance. Clinical trials will help advance a drug that has been jointly developed by more companies than a drug developed by a single company. Biotech companies, after realizing their first alliance, obtain higher valuations from VCs and the public equity market which implies that alliances represent a positive signal to prospective investors. There is a problem of information asymmetry. Prospective buyers (pharmaceutical firms) and investors (VCs) may not be provided with the same information as prospective sellers (biotech companies) and could not get the right insight about the quality of a biotech company's drugs and the competence of its management. This information asymmetry could be more pronounced in the preclinical phase, before empirical evidence on the drug's safety and clinical efficacy are available. Looking at the biotech firms' perspective,

they are reluctant to diffuse information about their research because of the risk of expropriation of their proprietary knowledge (Deeds et al., 1997; Janney and Folta, 2003).

1.3 Start-up funding

A start-up demands much more than just a great idea. It demands a lot of time, discipline, dedication, and most importantly, funding.

A 2016 British Business Bank Survey highlights the fact that more than 60% of start-ups require external funding rounds in order to establish their ground. So, start-ups need capital to finance their growth and expansion. Given the risky nature of an investment in a start-up, banks have historically been reluctant to lend to new companies that lack solid economic information, so they are forced to find capital from different sources to support the different phases of their business development. Start-Ups are partly limited in their access to the market, as their limited size and their young age make some financing options present in the market unavailable (Cassar, 2004). Without the possibility of having a record to show to investors that can represent an intermediate external finance provider, start-ups are argued to be seriously dependent on initial insider finance (Berger and Udell, 1998; Huyghebaert, 2001). Among those initial insider financiers, VCs play a significant role. They can drastically change the future business of the start-up, that otherwise would suffer from many difficulties in their development. Venture-backed firms are very dynamic in the sense that they grow more rapidly and flexibly than do their Non-Venture-backed firms (Hellman, 2000). They tend to uncover new investment opportunities faster, develop them quicker and more professionally and are ready to

discard and abandon less valuable projects than more seasoned companies (Hellman and Puri, 2000, 2002). In all, venture-backed firms have rapidly evolving investment opportunity sets that are dominated by very risky, yet potentially very profitable, growth options.

The different phases and sources of capital have been summarized in the graph (Fig 9) of Cumming and Johan (2009), which can be used as a complete reference for investor analysis.

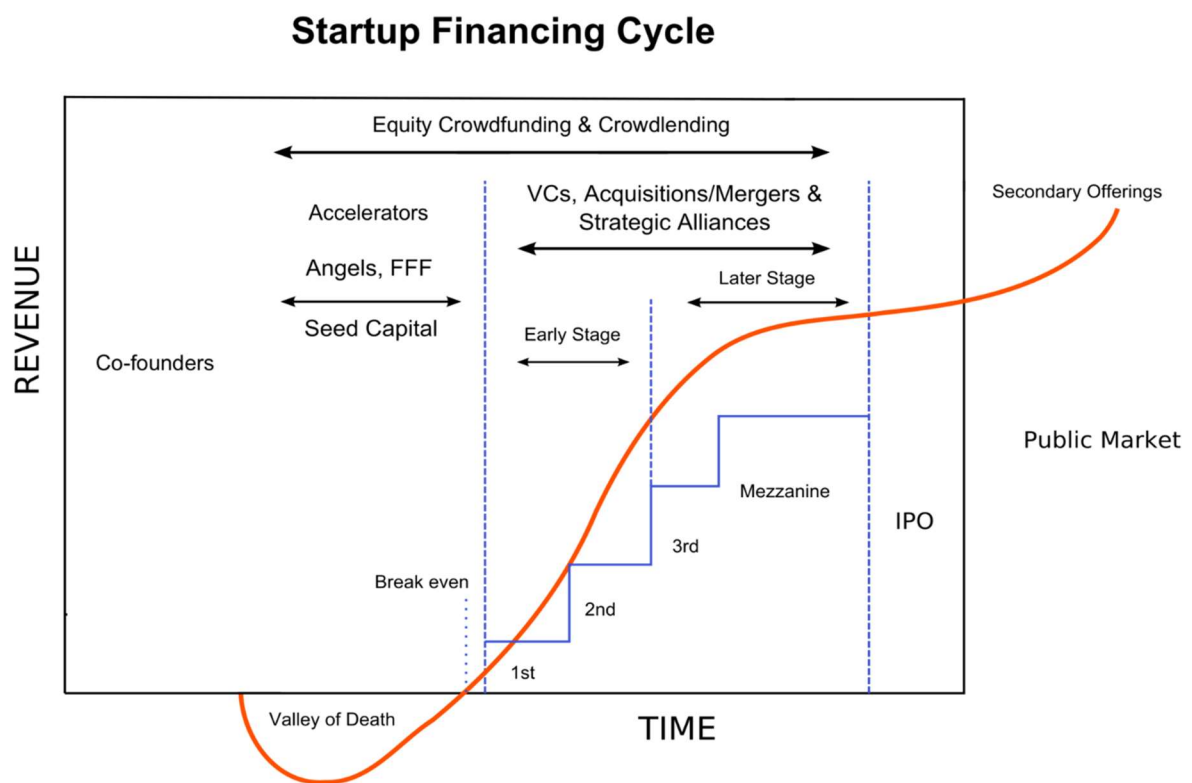


Fig. 9 Stages of entrepreneurial firm development (Cumming and Johan, 2009)

Pre-seed financing: this stage is commonly known as bootstrapping; it means using existing resources in order to scale the start-up. Start-up owners invest from their own pockets and try to grow themselves in the most resourceful manner. The main activities

performed by the owner during this initial stage are exploring the feasibility of building an idea into product/ service, testing the market and developing marketing and sales plan for the product launch. The most common pre-series investors are the Start-up Owners, Friends and Family (FFF) and possible Early Stage Venture Funds (Micro VCs). Moreover, during the pre-seed funding stage, start-ups value anywhere between \$10,000 to \$100,000; approximately fundraising it's \$ 50,000.

Seed financing: almost 29% of start-ups fail because they run out of capital while bootstrapping, which makes seed capital critical to get a business up and running. Because the investors are taking a huge risk by investing in the business, start-ups must provide them equity against seed funding. The stakes are even higher because, at this stage, start-ups cannot guarantee a successful business model.

During this stage, a start-up receives help in determining its final product and demographics. Seed funding allows a start-up to fund costs of product launch, build traction until revenue starts coming in and begin important hiring and make further market research for developing product-market-fit. The common types of investors who participate in seed funding are Friends and Family Angel Investors, accelerators and Crowdfunding.

Angel investors: they are previous start-up founders who have had exits and decide to invest the money in other start-ups or investors that despite not having a tech-related background decide to back companies in the space, given their potential growth and current market situation. Contrary to VC firms, business angels often invest their own money and, at one of the riskiest stages for start-ups, thus their importance in every single start-up market.

Accelerators: These organizations provide capital, mentorship and office space to teams in exchange for 5 to 10% of equity.

Crowdfunding: there are two types of crowdfunding that are closely tied to start-up investing. For hardware start-ups and creative projects, there's "reward-based crowdfunding". Users can back the projects they like and get something material in return, receiving no equity from the teams or companies providing such goods. The other kind of crowdfunding is equity crowdfunding. As the name indicates, in this instance investors of the companies get equity in return, thus becoming shareholders of the companies and being able to participate in the future return. This type of investing is often carried by platforms that serve as aggregators.

Start-ups that are eligible for seed funding have a business that values anywhere between \$3 million to \$6 million. The seed funding stage will facilitate funding from \$50,000 up to \$3 million for a promising start-up.

Early Stage-Round A: by now, the start-up must have a developed product and a customer base with consistent revenue flow. Now it's time for them to optimize their value offerings. This is an ideal opportunity that allows start-ups to scale themselves across different markets. In the Series A funding round, it's significant to have a working business model, that will generate long-term profits. Many times, start-ups come up with great ideas that can generate a substantial number of enthusiastic users, however, they do not know how to monetize it in the long run.

Series A funding mostly comes from angel investors and traditional VC firms. They are not looking for "great ideas", instead, they are looking for start-ups with a solid business

strategy that can turn their great idea into a successful, money-making organization, allowing the investors to reap the benefits of their investment.

Series A stage is the first round of VC financing. Start-ups with a good business plan valuing up to \$10 million to \$30 million are able to raise approximately \$15 million during the Series A funding stage.

Early Stage-Round B: Investors assist start-ups to expand their horizons by funding their market reach activities, increasing their market share, build operational teams such as marketing, business development, and customer success. The series B funding stage allows start-ups to grow in the way that they can meet the various demands of their customers and compete in tight markets in terms of competition. The main difference compared to the previous financing phase is the addition of a new wave of VCs specialized in investment in consolidated start-ups, to be able to further exceed expectations.

Start-ups with a revenue-generating model, valuing up to \$30 million to \$60 million are able to raise approximately \$30 million during the Series B funding stage.

Later Stage-Round C: Start-ups that make it to the series C funding stage should be on their growth path. These start-ups search for more funding that could help them build new products, reach new markets, even acquire other under-performing start-ups of the similar industry.

The Series C funding stage is related to growth intentions and focuses on scaling the start-up as rapidly as possible (Michaels et al. 1999). By now, the start-up operations have become less risky whereas more investors are coming in to play. In the series C funding stage, many hedge funds, investment banks, private equity firms will happily invest in

your start-up and receive a profit that is more than the money they invest. The reason behind this is that the start-up has already proven itself to be an operating success. New investors join the game by investing a significant amount of money into thriving start-ups to secure their own position as leading investors.

Start-ups with a good business growth valuing up to \$100 million to \$120 million are able to raise approximately \$50 million during the Series C funding stage.

Later stage-Round D: it is also called mezzanine round. It is usually the last venture round before a public offering and must close within 12 to 24 months before it (Houlihan, 1998). Not many start-ups find a need to go to this stage. The Series D funding stage allows entrepreneurs to raise funds for a special situation: for a merger but also if it has not yet hit the growth goal. The Series D funding offers start-ups the most viable solutions allowing them to negotiate issues head-on by acquiring another start-up as a merger. Also, if a start-up was unable to achieve its growth landmark with series C funds, then it will find a need to get more funds through series D funding to keep afloat. Potential investors are the same of series C funding stage.

Start-ups in this stage may value around \$150 million to \$300 million are able to raise approximately \$100 million during this start-up funding stage.

IPO: The IPO round is an equity financing event whereby the company raises capital in the public equity markets for the first time (Houlihan, 1998). This is not the end goal for all start-ups. However, if you have raised money through each of the preceding stages, going public is an option to expand further. All the investors who have traded their money for equity until this point will ideally recoup their investment along with additional profit. Some investors may retain their shares, but don't be surprised if many of them sell their

stock at the beginning to reap the rewards of getting in early. After the IPO, stock options for a growing company can be leveraged to attract top talent and the increased access to capital can provide resources to push the momentum of your business forward.

Understanding the different needs at each stage of funding will equip the start-up with the confidence to engage investors with a clear understanding of what all will get out of the exchange.

In the end, the raise of capital determines the very existence of the start-up and it is one of the necessary resources that a company must provide in order to operate. Moreover, the choices that are made on the capital, as well as on the use of debt and equity, have important implications on the risk of bankruptcy, performance, business operations and the potential expansion of the company. The start-up size strictly affects the measurement of long-term debt and external and bank loans (Cassar, 2004). Several theoretical studies link the size of a company with its capital structure. As the size of a company increases, an economy of scale is achieved which reduces information asymmetries, transaction costs, market access and risk exposure (Cassar, 2004).

1.4 Signalling theory

In contract theory, signalling is the idea that one party credibly conveys some information about itself to another party. It was initially developed by Michael Spence (1973) based on observed knowledge gaps between organizations and prospective employees, “the basic premise of signalling theory is that all of the necessary information for an

organization to predict an individual's future productivity is usually unobtainable" (Hannon and Milkovich, 1996, p. 405). Its intuitive nature led it to be adapted to many other domains, such as Human Resource Management, business, and financial markets.

In its formulation of signal theory, Spence used the labour market to model the signalling function of education. Employers lack information on the quality of the candidates; therefore, candidates obtain education to signal their quality and reduce information asymmetries. This can be, unanimously, considered a reliable signal, because high-quality prospective employees distinguish themselves from low-quality ones via the costly signal of a rigorous higher education. Spence's model stands in contrast to human capital theory because it does not focus on education as a means of increasing worker productivity, but instead focuses on education as a means of communicating the candidate's otherwise undetectable characteristics (Weiss, 1995).

Signalling theory is fundamentally concerned with reducing the information asymmetry between two parties (Spence, 2002).

The information influences the decision-making processes used by people in a big number of application fields (households, companies and governments). People make decisions based on public information, which is freely available, and private information, which is available only to a subset of the public. Stiglitz (2002) explained that information asymmetries occur when "different people know different things".

For more than a century, formal economic models of decision-making based on the assumption of perfect information, ignoring such information asymmetries (Stiglitz, 2002) or supposing that the presence of this phenomenon did not change general behaviour.

Stiglitz (2000) highlights two major types of information in which asymmetry is particularly important: information on quality and information on intent. In the first case, the asymmetry of information refers to when one party is not fully aware of the characteristics of the other. In the second case, the asymmetry of information refers to when one party is concerned about the behaviour or behavioural intentions of another (Elitzur and Gaviols, 2003). Much of the research in this area examines the use of incentives as mechanisms to reduce the potential moral hazard arising from an individual's behaviour (Jensen and Meckling, 1976; Ross, 1973).

As already pointed out, signalling theory is useful for describing behaviour when two parties, whether individuals or organizations, have access to the different levels of information. Generally, apart, the sender, must choose whether and how to communicate (or signal) such information, and the other party, the receiver, must choose how to interpret the signal.

So, the three central elements of signal theory are the signaller, the signal and the receiver. Referring to Connelly et al. (2011) review and the assessment of signalling theory we describe the three factors.

Signaller:

Signallers in management literature are generally executives or managers who have information about an individual (Spence, 1973), a product (Kirmani and Rao, 2000) or an organization (Ross, 1977), which is not publicly available. This information can be positive or negative and generally could have a lot of value for third parties. This information could include, for example, specific information about the organization's products or services. This information can be very different from each other; for example,

they could include research and development results in the initial phase or later phase news concerning preliminary sales results or other aspects of the organization such as pending lawsuits or union negotiations. In general, this private information provides insiders with a privileged perspective regarding the underlying quality of certain aspects of the individual, product or organization.

The signal:

Signallers have different information and must decide whether to communicate this information to outsiders or not. Signalling theory focuses mainly on the deliberate and intentional communication of positive information to convey positive organizational attributes.

The experts could potentially provide outsiders with many observable actions, but not all these actions are useful as signals. There are two main features of effective signals. The first is signal observability, which refers to the extent to which outsiders can notice the signal. Observability is a necessary but not sufficient characteristic of a signal; the cost of the signal represents the second characteristic that the signals must have. The cost of the signal is so central in signalling theory that some call it “costly signalling theory) (Bird and Smith, 2005). The notion of cost in the context of the signal implies that some signallers are in a better position than others to absorb the associated costs. The costs associated with obtaining a patent, for example, are high because the certification process takes a long time and these costs make fraud or false reporting difficult. However, the patent is less expensive for a high-quality producer than a low-quality producer because a low-quality manufacturer should implement many more modifications to obtain the certification.

The receiver:

According to the reporting models, the receivers are strangers who lack information on the organization in question, but who, above all, wish to receive such information. At the same time, the signallers and receivers also have partially conflicting interests, a deception could benefit the signaller at the receiver's expense (Bird and Smith, 2005). For signalling to take place, the signaller should benefit from some receiver action that the receiver would not otherwise have done; this usually involves the selection of the signaller in favour of some alternatives. For example, the recipient can choose to hire, purchase or invest. Examples of receivers are shareholders (Certo, Daily and Dalton, 2001) and holders of debts (Elliot, Prevost and Rao, 2009). Shareholders seek out signals that help close the gap between what shareholders know about the firm and what they want to know (Miller and Triana, 2009). A key point of this report is that these outsiders can earn, directly or in a shared way with the signaller, from making decisions based on the information obtained from these signals. Shareholders, for example, would benefit from buying shares in companies that signal more profitable futures.

1.5 Signalling theory in VC valuation

Signalling theory is becoming increasingly popular within strategic management research (Bergh and Gibbons, 2011; Connelly et al., 2011).

For example, strategic actions such as initial public offerings (Pollock et al., 2010), name changes (Lee, 2001), financial resources acquisition (Sievers, 2013) can be characterized

by lack of information and therefore create uncertainty for the interested parties on the future prospects of a company.

A central problem, for high-tech entrepreneurs during its start-up phase is obtaining external resources when their assets are intangible and knowledge-based. Science-based companies pose specific challenges to investors.

VCs have a fundamental role in identifying, funding, and/ or supporting innovative yet usually informationally opaque start-ups. In symmetric situations, capital would move freely into the VC market and investments will be provided to all positive net-present-value start-ups. Nevertheless, capital does not flow freely into the market (Kollmann and Kuckertz, 2010; Leland and Pyle, 1977). Start-ups are new to the marketplace and do not possess an observable track record (Hannan and Freeman, 1984; Morse et al., 2007; Shepherd et al., 2000) that the VCs can exploit as a criterion to manage their investment decisions (Macmillan et al., 1985; Muzyka et al., 1996).

In real market, it is very difficult to make VCs confident about the scientific quality of the technologies and products the high-tech start-up is developing, because there is a close link between basic research and development and the novelty of products, which in turn is a prerequisite for their commercial success (Zucker et al., 1998; Hoenen et al., 2014). Moreover, investors generally do not have the scientific knowledge necessary to assess the scientific potential of pre-IPO companies (Junkunc, 2007; Junkunc and Eckhardt, 2009). On the contrary, companies that are in the initial development stage are reluctant to disclose information about technologies and products due to concerns about appropriateness (Deeds et al., 1997; Janney and Folta, 2003). So, especially for entrepreneurs with no established reputation, convincing external resource providers like

VCs can be very challenging. In this context, it is fundamental a good understanding of the determinants and the mechanisms regarding the valuation of high-tech start-up performed by VCs.

Nonetheless, it must be taken into account that valuation is important not only for entrepreneurs but also for VCs, therefore the information asymmetry often represents a controversial point of negotiation in VC contracts and a problem in the construction of a VC-start-up relationship (Hsu, 2004; Hochberg et al., 2010; Gompers et al., 2010, etc., Kollmann and Kuckertz, 2010, Leland and Pyle, 1977). For VCs, their final return is positively associated with the difference between the proceeds of exit in a liquidity event (Initial Public Offering (IPO) or Mergers & Acquisitions (M&A)) and the price paid to invest in the company. For entrepreneurs, the valuation they receive in a financing phase determines the share of participation they must give away for a certain infusion of capital, which directly affects their loose of control over the company. This represents the reason why these companies need the funding of VCs, which thanks to their experience are able to select the most promising companies. A key contribution that VCs make is in designing and implementing solutions to these agency problems, such as staging their financing and encouraging firms to use substantial amounts of equity-based compensation. Nevertheless, because of the considerable uncertainties related to start-ups, the process of start-ups valuation by VCs is led in a significant part by a personal choice based on the information available.

The complexity and heterogeneity of this topic highlights the need for a conceptual integrative framework. This need seems to be satisfied by Kohn (2018), who provides an integrative framework (Fig. 10) that conceptualizes that start-ups' valuations in the VC context are determined by a three-sided interplay of different determinants related to start-ups, VCs, and the external environment.

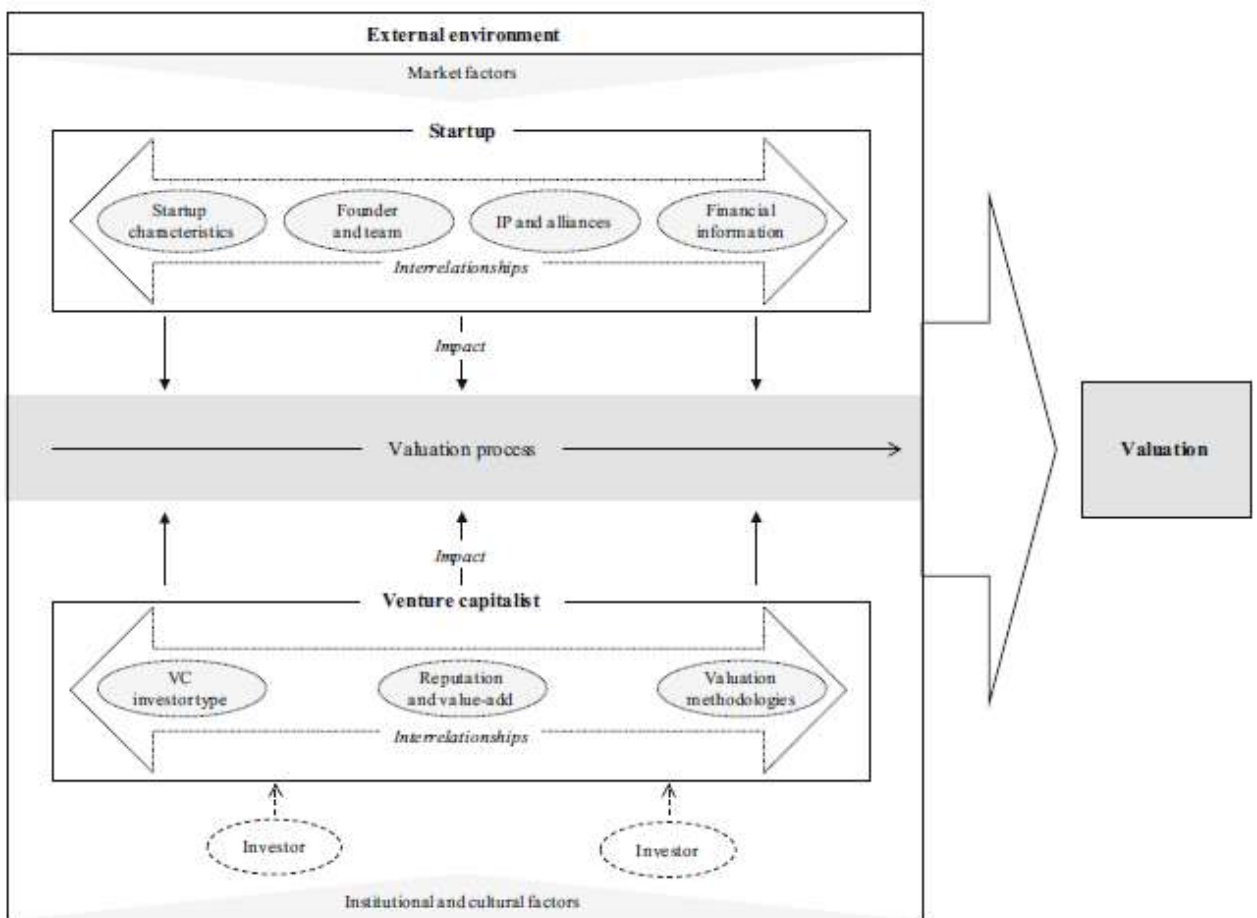


Fig. 10 Conceptual framework (Kohn, 2018)

1.5.1 Start-up signals

In order to investigate the start-ups' determinants that influence VCs' investment decision, we need to make a distinction between financial statement information (e.g. revenues, sales, general and administrative (SG&A) expenses, research and development (R&D) expenses, and cash) and non-financial information (e.g. team composition, CEO education, team experience, reference customers or the number of patents).

1.5.1.1 Financials signals

Although the role of financial statement information in valuing publicly traded equity securities has been studied extensively, there is little evidence regarding the role of financial statement information in the private equity sector. This is despite the large number of companies and the sizable amount of capital committed to private equities.

Entrepreneurs provide VCs with complete financial information, so the balance sheet and income statement data should provide investors with sufficient means to appraise a start-up's future financial performance. The problem is to understand whether and, if so, to what extent the current accounting information can explain the valuations (Manigart et al. 1997).

Only recent studies (Hand, 2005; Armstrong et al., 2006; Sievers et al., 2013) establish that accounting information is relevant in explaining the pre-money values of VC-backed firms beyond qualitative non-financial and deal characteristics. In their studies, the

authors focus on selected balance-sheet items (e.g. cash, non-cash assets, and long-term debt) and the main components of the income statement (e.g. revenues, SG&A costs, and R&D expenditures).

Hand (2005) pioneered this strand of research examining the value relevance of financial statement information for a sample of successful private VC-backed biotech start-ups in the USA. He finds that accounting information is value-relevant in the VC context and that cash, non-cash assets, and research and development expenses are associated with higher pre-money valuations. The importance of considering the asset structure is highlighted also by Cassar (2004), in order to contrast start-ups' information opacity. VCs, in most cases, are interested in early-stage companies that show rapid growth potential but have negative cash flow. It can occur that cash outflows will precede the inflow of revenue by various years (Armstrong, 2006).

For what concerns cash, Demers and Lev (2001) underline the negative impact that the cash burn rates (the rate at which a company uses up its cash reserves or cash balance) have on firm value. Therefore, cash levels are a big concern for investors (Davila and Foster, 2005) and higher cash levels will be associated with a positive pre-money valuation. Non-cash assets, defined as the total assets minus the cash assets, result in better VCs valuation since larger firms with more assets in place will generally face reduced risk (Mata and Portugal, 1994; Huyhebaert et al., 2000; Lussier and Halabi, 2010). Lastly, Hand (2005) showed that R&D expenditures can be considered as investments in the context of VC and are, therefore, regarded as value-enhancing, confirming the finding of Lev and Sougiannis, (1996). Later on, as further confirmation, Xu, Magnan, and Andre (2007) come up with the same results. On the contrary long-term debt has a negative relationship with the valuation denoting creditors' claims that

must be settled with the company's assets when due. Hand (2005) also finds that the value relevance of financial statements generally increases as firms mature. In contrast, the value relevance of non-financial statement information decreases as firms mature, indicating that in a dynamic sense, financial statements and non-financial statement information of venture-backed pre-IPO biotech companies are information substitutes in valuation, not complements. This finding has been confirmed later by Smith and Cordina (2014).

Armstrong et al. (2006), applying rank regression across industries of start-ups that went public in the USA, extend the research of Hand (2005). The study aligns with Hand (2005) in concluding that higher revenues lead to higher start-up valuation and that the same holds true for cost components (cost of sales, sales, marketing, general, and administrative expenses, research and development expenses).

Chandra and Ro (2008) find evidence that revenues represent a more relevant piece of information for loss-making companies.

Finally, while Armstrong et al. (2006) predict that SG&A (selling, general, and administrative) expenses will also capture investment activities of early-stage companies (positive effect on VCs valuation), we note that Hand (2005) does not make a clear prediction regarding SG&A, because it is a mixture of period expenses that provide benefits (e.g. management salaries), while it also includes pure cost items.

Sievers et al. (2013) using a hand-collected data set of German VC-backed firms report that financial statement information is also value-relevant for start-ups in Germany. Specifically, the study states that cash, revenues, and research and development expenses have a positive impact on start-up valuations, while selling, general, and administrative expenses have a negative effect, a finding countering that of Armstrong et al. (2006).

Moreover, Sievers et al. (2013) investigate whether financial statement information is, on average, substitute or complement for non-financial metrics discovering that balance sheet information explains approximately 51% of the variation of the pre-money valuations. The value of information is comparable to that of an exclusively non-financial model. Therefore, he finds that financial information is as powerful as non-financial information in explaining pre-money values. However, both sets of information appear to be, on average, complements, since both together have an explanatory power of 62%. This result is in contrast with Hand (2005), but also with the initial expectations of Sievers (2013). Indeed, he hypothesizes that the cash flow elements could become progressively less important when considering the characteristics of the team and other non-financial information such as the number of patents.

1.5.1.2 Non-financials signals

It has been highlighted in the literature that it is important to include a comprehensive set of non-financial indicators when evaluating the factors affecting VCs' valuation of a start-up. For instance, Shevlin (1996, p. 32) stated: “One implication of these results is that researchers could arrive at mistaken inferences about the value-relevance of financial accounting information if important non-financial indicators of corporate performance are omitted from the analysis”. We will analyse the different non-financial signals using as a roadmap the conceptual framework developed by Kohn (2018).

START-UP CHARACTERISTICS

Starting from the characteristic of the start-up, in general, the pre-money values increase with each investment round and with firm age. Gompers and Lerner (1999), Nicholson et al. (2005) and Seppä (2001) find that the older biotech firms the larger pre-money valuations. They attribute this result to the fact that older firms are less risky. Armstrong et al. (2006) find that the age is significantly and negatively correlated to the valuation among US start-ups. They hypothesize that this could be rooted in the time-to-exit logic of VCs since a longer time-to-exit is associated with lower returns. This is in contrast with what found by Sievers et al. (2013) who, indeed, believe that in Germany age is not taken into consideration when evaluating a start-up, but instead is more informative to conduct a new round of financing.

For what concerns the investment rounds, on average, valuations rise from round-to-round (Houlihan Valuation Advisors/ VentureOne, 1998).

Caves (1972) argues that product differentiation is one of the most important structural elements of a sector and is positively related to the company's performance.

Miloud et al. (2012) examined 102 French start-ups from 18 different sectors and focus on the impact of a sector on start-up evaluations, considering, in particular, its growth rate. Consequently, they illustrate that VCs assign higher ratings to companies operating in highly differentiated sectors and with higher growth rates. (Davila et al., 2015) investigate an international sample of start-ups, including their detailed management control system (MCS) adoptions and financing histories. They find that higher MCS intensity has a positive impact on company value. The valuation implication is more

pronounced for start-up companies operating in highly competitive environments and with higher growth. Similarly, there is an endogenous relationship, with growth-stimulating the adoption of MCS and MCS facilitating growth (Davila and Foster, 2005/2007; Sandino, 2007).

External financiers of start-up companies are expected to value MCSs for two reasons. First, financiers believe those systems lead to better decisions and better execution. As start-up companies grow, managers are involved in a wider variety of tasks and processes that are often complex and uncertain. Formal tools can support and enhance managerial decision making, coordination and enable better execution (Davila et al., 2009). The second reason is that MCS adoption signals a firm's managerial quality and potential future growth. Moreover, Davila et al. (2015) results suggest that investors believe that the benefits of adopting an MCS exceed its costs, which challenges the traditional view that the rigid and bureaucratic nature of these systems hinders the success of new ventures (Bhide, 2000).

Finally, the results of Davila et al. (2003) indicate that larger changes in the number of employees are positively and significantly associated with changes in equity value. It indicates that growth in employees, a variable that is typically more accessible and updated than equity valuation, can be considered a good proxy for changes in the valuation of a start-up over successive rounds.

ENTREPRENEUR AND TEAM CHARACTERISTICS

Factors that can increase start-up valuations include having more than one founder, a complete management team, prior start-up, management and relevant industry experience, and also the level of education. All these factors suggest more in-depth information on the quality of the start-up.

For what concerns the entrepreneur and his previous experience Siegel and MacMillan (1993) find that the number of years the entrepreneur has worked in a similar industry significantly and positively relates to sales growth. Similar findings are also reported by Gimeno, Folta, and Cooper (1997), who find that successful firms tend to be led by entrepreneurs who began their venture based on ideas developed in their previous jobs.

More recently, Hsu (2007) indicates that VCs are willing to pay value premiums for founder expertise. Similarly, Chatterji (2009) explains how in the medical devices sector, entrepreneurs with previous experience in an incumbent enterprise are enhanced with higher evaluations compared to other competitors in the last round of private financing.

Miloud et al. (2012) go even further and find that VCs value a new venture significantly higher if its founders have relevant industry experience, relevant managerial experience and start-up experience before having founded the current venture. Wasserman (2016) confirms the same general idea. The only study that suggests opposite evidence is Gompers et al. (2010), who report that successful serial entrepreneurs do not receive higher valuations for their new ventures.

Referring to CEO, Lerner (1994) finds that the VCs representation on boards of directors increased by 44% for firms in which the CEO had no prior experience in running an entrepreneurial firm. This may explain the subsequent finding of Wasserman (2016). He discovers that the companies, in which the founder is still CEO and/ or control the board of directors at the time of the current funding round, receive lower valuations. This, therefore, suggests that the founders would have to give up control to receive a higher rating and, reasonably, this happens with less experienced CEOs.

Sievers et al. (2013) find that a higher educational level of the CEO (university degree, PhD or professor) is associated with a higher valuation from VCs.

Most of the empirical studies are in-line that the level of education of the management team and founder are positively correlated with the value of the firm. However, this is contrast with Yoo et al. (2012), which result showed that the competency of an entrepreneur does not affect the market value of start-up companies in the new media industry and Cooper (1994) who found that the characteristics of an entrepreneur are crucial in the success of a firm, but it does not affect the growth of the firm and hence, value of firm.

Not only their level of education or their past experience are relevant, but also their personal network. In fact, Hsu (2007) and Wasserman (2016) report that the personal networks of the CEO are associated with higher valuations as these networks facilitate the recruitment of talented executive officers and technical staff. Hsu (2007) argues that this, therefore, suggests less effort on the part of VCs and signals the potential for high performance.

Referring to the top management team Sievers et al. (2013) finds that a high-quality management team increases both the level and the probability of positive future cash flows and, therefore, the pre-money value of the investment. Similarly, a high-quality team will reduce an investor's concerns about adverse selection.

Regarding team composition, Eisenhardt and Schoonhoven (1990) affirm that with the increasing technological complexity and competition, no one can have all the skills and knowledge necessary to compete effectively. For this reason, more and more new companies are founded by teams rather than by individual entrepreneurs. Coherently, Miloud et al. (2012) state that new companies founded by a team of founders are valued higher than those founded by a single founder. According to Muzyka, Birley and Leleux (1996) and Franke et al. (2008), the completeness and heterogeneity of a new venture's management team are among the main concerns for VCs. Beckman et al. (2007) and Miloud et al. (2012) have the same belief, that the more diverse the management team, the greater the likelihood of achieving milestones and making a successful exit. In particular, Sievers et al. (2013) investigate whether an entrepreneurial team consisting of both a CEO in charge of running the business and a chief scientific officer (CSO), who develops the underlying product and technology, achieves a higher valuation. They find that a team composed of a CEO and CSO indicates greater quality and easier growth.

INTELLECTUAL PROPERTY

There is empirical evidence that patents convey important information about the company and that they deserve considerable attention in the due diligence process.

Since the preparation of a patent application is expensive and requires some disclosure of private information to the public, companies should not underestimate the value of patents. They play an important role in the acquisition of financing because they reduce information asymmetry.

Most of the previous work on the role of IP in financing VCs has focused on patents. While some studies have shown a positive impact of the patent stock of high-technology companies on the amount of VC financing received (Baum and Silverman 2004, Mann and Sager 2007, Hsu and Ziedonis 2008), on VC valuation (Lerner, 1994) and on the likelihood of attracting a prominent VC investor (Hsu and Ziedonis, 2008), a thorough understanding of whether and how patents support the venture in attracting VC at all, is still missing.

Moreover, start-ups with patents demonstrate superior performance throughout the VC cycle compared to other start-ups, both in terms of survival rate and the amount of funding they receive (Cao and Hsu, 2011; Mann and Sager, 2007).

One of the first authors that investigate this phenomenon is Lerner (1994) that shows how the number and scope of patents for biotechnology start-ups lead to higher ratings by VCs and that intellectual property is a young biotech company's most valuable asset. More recently, Hand (2005), in the context of biotech start-ups, and Armstrong et al. (2006) across different industries, show that the number of patents is positively related to start-ups' pre-money valuation. Hsu and Ziedonis (2013) find the same results but also, that patent applications are more relevant in the first rounds of financing and this effect is even more pronounced when the founders have no previous experience in making a start-up public. Notwithstanding this, Hand (2005) reports that on a round-by-

round basis patents' value relevance is remarkably low. He uses the same general approach of Lerner (1994) except that he uses patents filed, rather than patents issued, as of the valuation date. Results are not sensitive to this distinction, but information gathered by VCs and patent lawyers, specializing in biotechnology, indicate that the average lag of about three years between a patent first filed and its first issue leads VCs to significantly weight patent filings. Hand (2005) hypothesized that the patent protection economy could have changed over time, so much that, it is now more valuable to hold a limited patent portfolio than a larger general purpose one.

During the pre-grant period the need to disclose unprotected knowledge may result in lower assessments. Greenberg (2013) estimates whether the granting of patents, which reduces uncertainty about the scope of intellectual property rights conferred, improves the initial assessments of VCs.

The results show a positive association between patent applications and company valuation. The additional impact of the granted patents is positive and significant for younger companies and during the first rounds of financing, but small and insignificant for the more mature start-ups. Moreover, he demonstrates that companies' patenting activities have consistent and cogent effects on the timing of VC financing. Having at least one patent application reduces the time to the first VC investment by 76% on average. When he investigates the quality of patents, which he measures with received citations, he finds that ventures with higher patent quality receive VC faster.

In another study, Audretsch et al. (2012) discover that VCs and business angels (BA) consider patent applications to be a signal of quality only if prototypes are also available. Furthermore, Audretsch et al. (2012) argue that the signalling value of patents is

contingent on patent feasibility. Although the patent-VC interface has received considerable attention in the literature, not much is known about the role of trademarks in VC financing.

Only a few studies specifically address the relationship between VCs and trademarks, suggesting that VC investors consider trademarking when they invest in a start-up (De Vries et al., 2013; Block et al. 2014).

A trademark is defined by World Intellectual Property Organization (WIPO), 2011 as “a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise”. Like patents, trademarks provide exclusion rights that not only guarantee a competitive advantage, but also identify the start-up with respect to its customers. While the patents refer to the technology base of a start-up, the trademarks reflect the preparation of the start-up, its plan to engage in marketing activities and its willingness to protect its marketing resources (Sandner and Block, 2011). In addition to their signalling value, trademarks have protection value, i.e., they protect a start-up's brands and marketing assets through the right to exclude others from the use of protected words, signs, or symbols. Another important positive effect of trademarks is related to the finding of Rujas (1999), who argues that after a firm's patent protection has expired, the firm can continue to appropriate returns from its previous invention through its trademarks. Firms can establish a bond of familiarity and trust with their consumers, which can continue to exist at later development stages.

Block et al. (2014) examine the relevance of trademarks and patents for start-up valuations, based on the fact that trademarks demonstrate a start-up's degree of market and growth orientation and its willingness to protect its current and future marketing

efforts. The authors report that the number and breadth of trademark applications have inverted U-shaped relationships with the financial valuations of start-ups by VCs, which implies that the additional costs in terms of coordination efforts exceed the advantages of a more diversified trademark portfolio, thus leading to lower start-up valuation. Moreover, the finding also indicates that in later funding rounds, the positive effect of new trademark applications decreases when the start-up progresses into a more advanced development stage.

It is therefore important to include both patents and trademarks when studying VC financing, as both forms of IP cover different aspects of the start-up's business model and increase VCs valuation.

ALLIANCES

Alliance structures include a wide range of inter-organizational agreements, from more formal joint venture agreements with shared actions to relatively informal cooperation agreements (Judge and Ryman, 2001).

Properly structured alliance agreements provide access to the partners' knowledge, skills and resources while preserving control and limiting the loss of flexibility (Hitt et al., 2001).

Alliance formation is a strategy used by entrepreneurial companies to access resources in their attempts to create value and to signal investee quality, thereby reducing information asymmetries. Each alliance requires the entrepreneurial firm manager to

identify potential alliance partners, negotiate the alliance agreement, conceptualize the alliance stage of development, and navigate the firm through the activities that serve the alliance and its objectives (Kale et al., 2002).

Based on signalling theory, Nicholson et al. (2005) report that biotechnology companies that sign strategic alliance agreements with other biotechnology or pharmaceutical companies receive higher pre-money valuations. Miloud et al. (2012) and Sievers et al. (2013) arrive at the same conclusion for French and German start-ups. The larger the size of the network, the more extensive the level of collaboration is and the higher the valuation of the VC.

Although Hand (2005) believes that the valuation effect on a round-by-round basis is remarkably low, its results are consistent with those of the others, as the number of strategic alliances is, on average, positively associated with the valuations of biotechnology start-ups.

Zheng et al. (2010) show that the inter-organizational network of a start-up, in conjunction with its ability to innovate, influence its performance and its assessment by VCs.

Referring to the same topic, Moghaddam et al. (2016) show that for software-based start-ups supported by VC in the United States, alliances have a positive impact on pre-IPO valuation. However, too many alliances can decrease the valuation due to a lack of resources and capacity of the start-up to manage a large number of alliances.

Finally, Zheng et al. (2010) show that the valuation effect in terms of network status of a start-up (external resource) decreases, while the effect of its innovative capacity (internal resources) increases as the start-up matures.

Overall, as already seen for intellectual property, VCs seem to view alliances as a mean to reduce information asymmetries and as a value-enhancing factor emphasizing their importance for start-up valuations (Block et al. 2014).

1.5.2 VC signals

We now look at VCs' characteristics affecting start-up valuation.

Bengtsson and Hsu (2010) show that the personal characteristics of VCs and, not only those of the founders, help explain the matching between VCs and entrepreneurial firms. Hsu (2004) uses a hand-picked sample of 246 first-round professional offers to 149 US start-ups to show that entrepreneurs receiving different offers tend to prefer lower valuations by highly reputable VCs, indicating that entrepreneurs accept a discount assessment in anticipation of better value-added services provided by the VC with a solid reputation.

The same is shown by Cumming et al. (2012), who confirm that VC reputation is an important factor that determines the dynamic matching between entrepreneurs and VCs. The study shows that entrepreneurial firms with upwardly revised perceived quality try to switch to more reputable VCs if they were affiliated with less reputable VCs in early rounds: switching, entrepreneurial firms, obtain smaller capital infusions and often accept lower pre-money valuations.

So, starting from these results we deem fundamental to investigate which are the characteristics of VCs that are considered more valuable by start-ups.

Compared to the literature on the selection criteria used by VCs to evaluate entrepreneurial ventures, the literature on the criteria used by entrepreneurs to select VCs is quite limited.

VCS INVESTORS TYPE

The most easily observable determining factor on the risk capital side is the type of risk capital investor.

Heughebaert and Manigart (2012) assume that VCs are heterogeneous and that the type of VC company goes along with bargaining power, which means that VC firms with greater bargaining power are expected to negotiate lower valuations compared with VC firms with less bargaining power. By linking deal sourcing and VC investment strategy with bargaining power, Heughebaert and Manigart (2012) find that for 180 Belgian start-ups supported by VC a flow of proprietary deal (as in the case of VC university companies) and lesser competition from investors (as represented by government VCs destined for niche markets) leads to lower start-up valuations than those established by independent VCs, in line with the arguments on bargaining power mentioned above. Interestingly, the same study notes that the ratings of corporate VC companies match those of independent VCs. Similarly, Sievers et al. (2013) find that corporate lead investors do not significantly influence the valuations of German start-ups, whereas, for instance, Hand (2005) reports that they have a significantly positive effect on a sample of US biotech start-ups.

The Hand (2005) finding is in line to the one of Gompers and Lerner (1999), who previously state that corporate investors assign higher pre-money valuations when investing in private equity financings than do VC funds. Either because corporations perceive to be strategic synergies available, or because corporations typically engage in less monitoring and business development than do VC funds and therefore earn a lower expected return on their investment.

Moreover, Masulis and Nahata (2009) find that corporate VCs, which invest in competing start-ups (in comparison to the VC's parent company), assign higher valuations than their complementary counterparts which invest in start-ups with complementary relationships. They argue that this is in line with standard bargaining theory and is connected to the potential for moral hazard issues that start-ups might face when they deal with a competitive corporate investor.

Besides, Yang et al. (2009) try to explain the start-up valuations set by corporate VCs by applying organizational learning theory. The authors consider corporate VCs' valuation capabilities, which is not to over evaluate start-ups, as a learning process that enhances with experience. The authors' sample of 166 US public firms with corporate VC investments in over 1600 ventures supports the notion that corporate VCs' valuation capability improves with stage diversity, which is the degree of experience of investing in start-ups from different development stages.

REPUTATION AND VALUE-ADDED

The reputation of VCs, their experience in bringing the portfolio companies to a successful exit and their network with other VCs are important determinants for raising follow-on funds and accessing high-quality deal opportunities (Gompers, 1995), (Nahata, 2008), (Hochberg et al., 2007).

Knowledgeable practitioners, such as VCs, seem to believe that entrepreneurs' experience is important to understand their behaviours. Only by focusing on how VCs and entrepreneurs react to a stream of experiences can we understand the role of experience in influencing decisions and action outcomes.

Westhead et al. (2005) evidence suggests that, in the domain of entrepreneurial finance, experienced entrepreneurs are more likely to leverage their previous experience to select among VC term sheets.

The literature also postulates that the concept of entrepreneurial alertness implies a distinctive set of perceptive and cognitive processing skills, that directs the process of identifying opportunities (Gaglio and Katz, 2001). In this way, entrepreneurial alertness can be seen as a continuum. As a result of their experience, some entrepreneurs can, therefore, be associated with higher levels of alertness, while novice inexperienced entrepreneurs are associated with lower levels of alertness. Novice entrepreneurs also seek more information than experienced entrepreneurs (Cooper et al., 1996). They link this finding to the overconfidence of habitual entrepreneurs. This evidence is in line with Kirzner (1973/ 1997)'s "environmental alertness perspective". In this perspective, Westhead et al. (2005) suggest that experienced entrepreneurs may have higher levels of

alertness, and therefore they may not need to search for vast amounts of information to identify an opportunity.

Subsequent research attempted a theoretically based normative recommendation for appropriate criteria by which entrepreneurs may select a variety of different types of capital's provider (Leshchinskii, 2003). This research also argued that the screening capabilities of VC investors add value to the entrepreneurial firm by solving uncertainties, a result subsequently confirmed by studies that suggest that, in an efficient market, these investors are rewarded for value creation (Ippolito and Bertoni, 2004), (Valliere, 2007). The value of this differential screening ability has been shown to act as a signal of VC investor quality, which may attract the more desirable entrepreneurs since high-quality entrepreneurs will seek out high-quality VC investors (Kelly and Hay, 2000; Berkovitch and Serban-Levy, 2004; Valliere, 2005).

Hsu (2004) documents that entrepreneurs, who receive multiple financing offers, favour more reputable VCs and are willing to turn down the best financial terms from less reputable VCs. They accept harsh financial terms from more reputable VCs expecting that the more reputable VCs can bring better value-adding services. The reputation of VCs depends on their experience, information network and direct assistance to the portfolio firms. This result is confirmed by Bengtsson and Sensoy (2011).

Beyond that, Fitza et al. (2009) establish that the capacity of VCs to add value varies considerably, and some VCs can even have a negative effect. The results of Falik et al. (2016) show that there is a negative relationship between the start-up experience and the importance that entrepreneurs attach to the valuation but also, that the importance attributed to the network and to the reputation of a VC company moderates this

relationship. While inexperienced entrepreneurs attach more importance to valuation than experienced ones, they tend to consider it less if they want to gain access to the VC's network of contacts.

Moreover, entrepreneurs have shown to be more concerned with valuation when they approach less reliable VCs, particularly if they have considerable start-up experience. Cumming and Dai (2013) study the dynamics of positive sorting in the VC industry; they report that companies with better future performance potential are more likely to switch to more reputable VCs and, in those start-ups, lead VCs generally achieve higher valuations.

Finally, Cumming and Dai (2011) examine the effects that the VC fund size has on the valuations of start-ups. The findings suggest that fund size is in general positively associated with VCs' bargaining power, which allows them to get a lower price for their investments. In view of this, it should be remarked that fund size can also serve as a measure of VCs' quality, and thus their reputation (Bengtsson and Sensoy, 2011; Kaplan and Schoar, 2005). However, when the fund becomes unnecessarily large, the diluted attention, due to human capital constraint, kicks in and reduces VCs' outside option to attract other start-ups, which weakens their negotiation power and thus increases pre-money valuation. For the less reputable VCs, who often have weaker inside governance mechanisms, agency problems may also play a role in paying too much for certain investments.

This finding supports the notion that there is diseconomy of scale in the VC industry, which is partially due to the constraints from the quality and quantity of human capital when fund size grows.

VALUATION METHODOLOGIES

De Angelo (1990), Wright and Robbie (1996) argue that evaluation methodologies are a fundamental and decisive ingredient in the evaluation process, since, derived valuation, generally provide an important indication of the range within which a final evaluation will be negotiated.

It is fundamental what reported by Baeyens et al. (2006); they pointed out that one of the major causes of failed negotiations is the coexistence of conflicting opinions on valuations. His study reveals that this phenomenon is even more severe in the reference of biotechnological companies, in which the VCs do not consider the standard assessment methods sufficiently reliable and in turn prefer qualitative methodologies. Therefore, it is normal that VCs usually apply multiple assessment methodologies and then prioritize a particular method (Wright and Robbie 1996).

Otherwise, Dittmann et al. (2004), reporting on a sample of 53 German VCs, establish that VCs using several assessment methodologies show a significantly reduced rate of failed investments.

It is interesting how Dittmann et al. (2004) demonstrate that VC valuations based on the DCF (Discounted Cash Flow) method, combined with a discount rate in line with the CAPM or WACC (Weighted Average Cost of Capital) approaches, have a better investment performance than their peers.

Moreover, Lockett et al. (2002), Manigart et al. (2000) and Wright et al. (2004) discover that the use of specific assessment methods varies according to institutional settings.

Because of this, Dittmann et al. (2004) for Germany, Karsai et al. (1997) for Hungary, Karsai et al. (1998) in addition to Poland and Slovakia, Manigart et al. (2000) for Belgium and the Netherlands, Pintado et al. (2007) for Spain and Sander and Kõomägi (2007) for Estonia show how the DCF method is very popular in these countries, while it is rarely used in English countries, based on common law system. An explanation for these results is that those markets lacked appropriate benchmark valuations at the time at which they studied are based, which lead VCs to use the DCF evaluation method.

Equally interesting is that Manigart et al. (1997) show that VC levels of required returns vary from country to country. For example, French VCs require lower returns than their UK counterparts, although, the lower required returns of the sample are those required by Belgian and Dutch VCs. This implies that theoretically, UK VCs should assign lower valuation to start-ups.

Another important element to take into consideration is the perceived risk.

Indeed, Manigart et al. (1997) underline that the compromise between risk and return plays a crucial role in start-up valuations. In this perspective, Manigart et al. (1997) and Pintado et al. (2007) show that higher perceived risk leads VCs to demand higher required returns and therefore a lower valuation. This finding is also in line with those of Houlihan Valuation Advisors/ VentureOne (1998); they show that the first rounds of financing are generally associated with lower valuations.

Seppä and Laamanen (2001), studying a sample of VC investments in the United States, provide similar empirical evidence, that the chances of success, of risk-neutral start-up, are lower in their early stages. This is attributable to the risk of failure of a start-up that is

much higher in the early stages and which should decrease when the start-up reaches the most advanced stages of development (Engel, 2004; Ruhnka et Young, 1991).

In general, to derive the right risk-adjusted rate of return, typically based on the CAPM (Capital Asset Pricing Model), investors should only be compensated for systematic risk, since the unsystematic risk of a project can be diversified away (Brealey et al. 2011).

Cochrane (2005), based on a subset of data of Hwang et al. (2005), notes that the systematic risk for start-up investments decreases on a round-by-round basis (average beta of 0.6), while Korteweg and Sorensen (2010) find an average beta of 2.8.

An explanation for these different results may be that the former utilizes data provided by Sand Hill Econometrics (now incorporated in VentureSource), instead the latter uses a more recent dataset, which has been corrected for previous data problems. Ang and Sorensen (2012) conclude that the highest beta of 2.8 seems more coherent within the start-up context.

It is interesting to note that Seppä and Laamanen (2001), comparing the predictive power of neutral and adequate approaches to risk, discover that the former better explains future valuation in terms of the binomial model. Reber (2014) extends this research by combining the binomial model with cascade neural networks and shows that, even if the estimation errors remain relatively high, this approach has greater predictive power than risk-adjusted valuation approaches, regular neural networks and linear regression models.

Chapter 2. Research framework

The chapter is structured according to the following scheme: first, we will explain the reasons for the study and the research question, which represents the beginning of our thesis development. Then we will illustrate the research hypotheses adopted, motivating and contextualizing them in the literature.

2.1 Research question

This study aims to empirically evaluate how both the characteristics of the start-up and the VC impact on the company's valuation as the pre-money varies. Our research fills an important gap in the literature since previous studies on VCs and start-ups have focused only on one side of the deal contractor. In light of this, our objective is to analyse both the actors (start-ups and VCs) referring to the same sample. On the one hand, some researchers investigate the effects of the financial characteristics and the non-financial characteristics on the valuation made by VCs (Armstrong, 2006; Hand, 2005; Sievers, 2013). On the other hand, previous literature focuses on how different VCs' characteristics affect entrepreneurs' selection of different VC investors' offers (Hsu, 2004; Sahlman, 1997; Sorensen, 2007).

For what concerns the valuation of financial and non-financial elements we start from considering the results of Hand (2005), who shows that the relevance of financial statements generally increases in later stages of financing and, in contrast, the relevance of non-financial information decreases. This indicates that financial and non-financial information of venture-backed pre-IPO biotech companies is substituted in valuation, not complements. However, the findings of Hand (2005) have been questioned by Sievers (2013), who finds that financial information not only is as powerful as non-financial information in explaining pre-money valuations but also that the two factors combined are complementarity in assessing a more accurate valuation.

Thus, we aim at investigating: 1) the impact of start-ups' non-financial characteristics on VC deal valuations, and 2) the impact of VC firm characteristics on VC deal valuations.

We consider important to take into account the characteristics of VCs since from the literature, we have insights on the fact that not only the VCs select the start-up, but also the entrepreneur selects the VC (Cumming et al. 2012; Hsu, 2004; Sahlman, 1997). The capital supplied is not the only criteria considered in the deal. There are many other criteria, equally valuable, related to extra-financial services that can be better provided by more experienced VCs. For this reason, we want to assess the influence of specific elements characterizing the reputation of VCs. However, these studies keep the characteristics of the start-ups fixed.

Therefore, our research aims to investigate both the effects of these characteristics on the valuation in the early-stage financing rounds. This is done separately but in parallel to verify previous studies in a new context. A remarkable difference in our study is that we focus on a sample of biotech firms in the European VC market, which has been disregarded by previous literature. Hand studies biotech start-ups in the US market and Sievers has at his disposal a sample of German start-ups belonging to different industries.

2.2 Hypothesis

The specific characteristics previously analysed are related to the elements arose from the study of the literature previously led. Nevertheless, we had to focus on specific characteristics that are available in the VICO dataset.

To determine the valuation we have divided the relevant factors into three categories that express the elements of the start-up and the VC. The first two categories include non-financial information that refers to the founders' characteristics of the start-up that influence VCs' valuation and are respectively education and experience. They are considered of great significance for investors especially in the early-stages (Hand, 2005). The third relates to the experience of the VC that instead impact on the start-up's selection process of VCs. Our objective is to investigate at first these three categories individually and then to investigate jointly education and experience of the founder. This classification is the starting point for the development of the hypotheses that will be tested in this research.

The first basic hypothesis is related to the educational background of the company team. In particular, the direct effect of the presence of a professional with an MBA within the management team of the company or with years of education in managerial fields. Higher levels of education are related with greater levels of innovation (Bantel and Jackson, 1989; Kimberly and Evanisko, 1981; Wiersema and Bantel, 1992). Higher educational level (Sievers et al. 2013) influence individuals' information processing and receptiveness to innovation boundary spanning (Bantel and Jackson, 1989) and are positively related to strategic change (Wiersema and Bantel, 1992). Moreover, from Colombo and Grilli (2005) we know that graduate education in economic and managerial fields and, to a lesser extent, in technical and scientific fields, has a positive effect on the potential growth of a tech-based start-up during its early stages.

It's very common for start-ups in the biotech sector to have founders with high educational background in technical studies related to biotechnology (Prevezer, 2001).

Since this is an underlined characteristic of the majority of biotech start-ups it has not a signalling effect for VCs, and, for this reason, it has not been investigated in the literature. The young biotech companies are composed of two fundamental areas: scientific and managerial. On the contrary, the latter can be structured significantly differently from company to company, therefore it used by VCs to face and reduce information asymmetry (Gompers, 2016). This effect has been investigated and the management team is considered as an important factor by 95% of VC firms questioned and as the most important factor by 47% of VC firms. Teams are likely to have greater performance potential when they possess a greater educational heterogeneity. This is associated with a greater diversity of information sources, an intensification in range of perspective, beliefs, experience, values, cognitive benefits such as innovation, variety of perspectives, number and quality of ideas, and lastly a decision making empowered with creativeness and innovation (Bantel, 1993; Milliken and Martins, 1996; Tihanyi et al., 2000; Wiersema and Bantel, 1992).

As management team characteristics reflecting in the heterogeneity of the team have a positive effect on valuation and the undergraduate and graduate education in economic and managerial fields positively affect the growth, we expect a similar effect by the information that attests, in a different way, management capabilities. There aren't studies, so far, that have focused on the managerial education background of the entrepreneurial team and its possible impact on VCs valuation. Therefore, one of the objectives in our study is to test if one of the founders possesses an MBA or spent a long time in studying managerial subjects, the start-up is more likely to obtain a higher pre-money valuation.

Starting from these reflections, the first hypothesis can be explicated:

H1: *The presence of an entrepreneurial team member with an MBA or managerial education has a positive effect on the pre-money valuation.*

Secondly, we analyse the effect of the experience of the start-up team. In its broad sense, experience is meant as a combination of industry, technical, management and start-up knowledge.

Since in the first studies about the composition of companies, education and experience (or functional background) have been considered among the main determinants of the company team heterogeneity (Hambrick and Mason, 1984), signalling theory claims that both are helpful for investors to get a more precise perception of the company value. They are considered proxies for psychological attributes that influence strategic choices and firm performance.

Miloud (2012) certifies that the bundle of technical, industrial and managerial abilities has significant relevance and, therefore, the VC values a new venture significantly higher, any time its founders have relevant industry, managerial and start-up experience before they founded their current new venture.

Within the sphere of experience, we take into account four variables that can be traced back to three factors, that we translate into three different hypotheses. The first factor we highlight is the previous experience in the industry. The literature widely testifies that, especially in science-based sectors, entrepreneurs that acquired significant expertise in the incumbent industry are more likely to succeed in their new adventure. Chatterji (2009) explains how in the medical devices sector, entrepreneurs with previous experience in the incumbent enterprise are enhanced with higher valuations compared to other competitors. Furthermore, Gimeno, Folta, and Cooper (1997) find that growth firms tend

to be led by entrepreneurs who began their venture based on ideas developed in their previous jobs. Potential entrepreneurs can utilize their experience at an incumbent firm to acquire financial resources, accumulate social capital, augment their technical skills, and identify entrepreneurial opportunities. The goal of our research is not to deepen the existing literature by trying to further confirm these findings, but, rather, to focus our attention on the possibility of having a different and even an opposite effect. In our opinion, the presence of a figure with previous experience as a chief manager in a biotech company (*Exp_C_lev_biotech*) may, differently from what demonstrated so far, have a negative impact on the valuation of a start-up. The idea arises from the fact that biotech start-ups, in particular the ones coming from academic spin-offs, are usually characterised by technicians with a limited social network of the industry and of managerial figures outside the industry (Cooper and Daily, 1996), therefore inadequate contacts with non-technical people. Because of the higher difficulty that VCs may face in trying to assign these roles to more experienced and reliable professionals, investors are more skeptic in evaluating start-ups with top-tier managers with previous experience as a chief manager in the same industry. VCs are more willing to participate in the start-up when they could recruit themselves a functionally balanced professional team that could almost replace the original founding team at the managerial level (Roure and Keeley, 1990; Cyr et al, 2000). We argue that when start-ups have figures with previous experience in the biotech industry as chief managers, investors are not persuaded anymore to invest and, as a consequence, their valuation decreases. Their presence would obstacle investors' will to replace them, since the possibility that the team reacts in a negative way to a change of the manager increase and this may lead to a drop in the company's performance. (Clarysse, 2004).

Starting from this reflection, the following hypothesis is formulated:

H2a: *The presence of a founder of the focal start-up with previous experience as a top-tier manager in the same industry has a negative effect on the pre-money valuation.*

The other factor selected is the presence of a member with past experiences as the founder of start-ups within the company. Hsu (2004a) provides consistent data proving that thanks to their prior experience they can reduce the uncertainty VCs face during the funding decision. Entrepreneurs with a series of successes behind them show a certain persistence in choosing the right industry and a predisposition to start a new venture timely (Gompers, 2010). The study from Gompers, Kovner, Lerner and Scharfstein (2010a) shows that past success as an entrepreneur is an important factor that VC firms focus on when attracting potential investments. In addition, Sievers et al. (2013) evaluate how, if the members of the management team have already founded a start-up, the chances of success are considerably higher. This happens because, even before there is evidence of consistent positive results, the perception of persistent performance based on the entrepreneur's track record induces suppliers and customers to commit resources to the company and to trust him.

We decide to investigate the potential positive effect considering two different variables. The decision takes into consideration the distinction existing in the literature, highlighted by Becker (1975), between the *generic* and *specific* components of human capital. Generic human capital relates to the general expertise developed by entrepreneurs through both formal education and professional experience. Specific human capital, instead, involves capabilities that founders can precisely apply to the entrepreneurial job in the freshly conceived firm. The first variable (found_Startup_bio) attests the specific

knowledge and determines if one of the founders already possesses experience as founder of a biotech start-up. The second one (*found_Startup_no_bio*), related to generic capabilities, is meant to be complementary checking whether the entrepreneur has already been the founder of a start-up of an industry that does not belong to biotech. This variable is meant to work as an additional control in our analysis.

Based on these reasonings we outline the following hypothesis:

H2b: *The presence of a founder with previous experience as founder of a start-up, in both biotech and non-biotech has a positive effect on the pre-money valuation.*

Finally, we select another variable, namely *exp_VC*, to indicate if one of the founders had previous experience as VC. The theory does not specifically investigate this characteristic of the founder, but we expect this factor to have a positive impact on the final valuation, especially in the view of three resulting elements:

1. A greater capacity for negotiation of the founder;
2. A more extensive social network in the industry from which to take advantage;
3. A better understanding and knowledge of the characteristics of a company that have to be stressed to positively impress investors during the pitch.

Previous experience in the investment sector may gather the entrepreneur with higher capacity in understanding the implications of contractual covenants and negotiating conditions in terms of his own best interests (Falik, 2016).

This led us to conceive further hypothesis:

H2c: *The presence of an entrepreneurial member with a previous VC experience has a positive effect on the pre-money valuation.*

A fourth relevant topic is the reputation of the VC. As stated earlier, VCs have different characteristics, value-added potential and can offer several services to young companies apart from the capital. Hsu (2004) shows in his studies how VC reputation benefits the invested firm and documents that entrepreneurs, who receive multiple financing offers, favour more reputable VCs and are willing to turn down the best financial terms from less reputable VCs. They accept severe financial terms from more experienced VCs expecting that they can bring better value-adding services. Every additional investment enlarges VC's information network in two possible ways: obtaining prominent social contacts and/ or gaining experience in successfully structuring contracts and/ or monitoring entrepreneurs in the industrial sector (Sorenson and Stuart, 2001). Moreover, Gompers (1996) proposes to use the VC age as a proxy for the investor experience. Hence, this study predicts that VC experience is negatively related to the importance attached to valuation and contractual terms in favour of a higher consideration for the resources possessed by the VC firm.

Starting from these reflections, the last hypothesis can be explicated.

H3: *The VC experience in terms of companies invested and his age have a negative effect on the pre-money valuation.*

Chapter 3. The sample

3.1 Dataset Design

A panel data design is utilized in this research study, and a quantitative econometric approach is used to test the hypothesis presented before.

VICO is the result of a European project with the purpose of creating a dataset of VC investment to evaluate the effect of venture capital on start-ups. Additional information about VICO is produced in section 3.2.1. The information available in the dataset refers to the investments made by different investors for different European companies, all of them belonging to the biotech sector, in specific dates and rounds. The dataset considers the period between 2000 and 2015. This dataset is merged with other datasets to create

an appropriate data panel for our research. The initial dataset contains 78,451 observations. We have a very large dataset that includes even investments belonging to very late stages, we have a maximum of 19 rounds.

Round Number	Number of Investors	Percentage
1	38235	48,682%
2	17622	22,437%
3	9150	11,650%
4	5202	6,623%
5	3008	3,830%
6	1876	2,389%
7	1211	1,542%
8	806	1,026%
9	504	0,642%
10	339	0,432%
11	201	0,256%
12	115	0,146%
13	111	0,141%
14	62	0,079%
15	62	0,079%
16	18	0,023%
17	14	0,018%
18	3	0,004%
19	2	0,003%
Total	78541	100%

Table 1 Numbers of Investors per round

In order to balance our dataset, we observed the frequency of the investments in the various rounds and we find that the investments related to the sixth round or later can be excluded since they constitute only the 6.78% of the total. This reduces the dataset to 73,217 observations. Also, it is significant to clarify that, in a limited number of cases, multiple rounds take place in the same year. We consider all of them.

The total invested equity and the quota are included as variables. The former indicates the total amount of equity that the various investors have provided during a single investment round to a start-up, thus it does not comprehend the value of equity invested by a single investor. The latter indicates the percentage of the company that the single

investor has obtained by his investment. Since we have to work with the VCs pre-money valuation, the first restriction we introduce is the elimination of all the investment rounds for which we do not have either the information of total invested equity or quotas. In particular, in our dataset, there are many investment rounds in which not all the values of the quota of the single investor and/ or its total equity are provided. Moreover, we want to assure that our dataset considers only start-ups and not established companies. Therefore, we discriminate the observations based on the variable *AgeAtFirstInvestmentReceived*. We want to exclude all the companies that received their investment long time after their founding, so seven years is adopted as the maximum threshold. Applying these three filters (equity investment, quota and age) reduces significantly the size of the dataset to the number of 103. Then we proceed by calculating the pre-money. The formulas applied are:

$$PreMoney = Valuation - Total_Equity_invested \quad (1)$$

Where:

$$Valuation = \frac{Total_Equity_invested}{(Quota_tot^2)/100} \quad (2)$$

² Quota_tot is computed as the sum of the quotas of every investor in the same investment round.

We focus on the biotech industry in line with the work of Hand (2005), resulting in 72 start-ups. The final dataset used in our analysis results from the merge of the initial VICO one with other three different sources of data. This merge allows us to have available all the information regarding both the start-ups and VCs characteristics needed for our research.

Starting from the VICO database, each observation includes firstly time-invariant information related to the company, as the name, a code assigned by VICO (CompanyID), location, the foundation year, the year at the first investment received and the main industry in which it operates, identified by the NACE classification code.

The second set of variables (Orbis) includes different financial information of the companies: total assets, current assets, intangible assets and total debts.

The third one is obtained by merging data belonging to the Orbis dataset with complementary information gathered on LinkedIn. It refers to the human capital of the entrepreneurial team members, namely Education and Experience. On the education side, there several dummy variables that attest whether in the start-up team there are people who have: a technical PhD, a management PhD, an MBA, either a general or a more specific one, considering only prestigious MBA universities. Moreover, it is stated the mean number of years that the members of the team spent in technical education or in managerial one.

On the experience side, we have variables that show previous experience of the founders as VC, a top-tier manager in biotech companies, founder of a biotech start-up and founder of a start-up non-belonging to biotech.

Finally, the last set of variables coming from the Thomson Eikon database is related to proxies of VCs reputation: the age of the VC firm and the number of companies the firm has invested in. We decide to take into account the oldest VC firm participating in the investment and the mean of the companies the different VCs have invested in. It is important to specify that all the VCs we consider are currently active.

3.2 Data Analysis

In the section below 3.2.1 we provide a detailed description of the VICO dataset: its origins and composition. The decision of focusing only on this database derives from the fact that it represents the starting point for our analysis: it contains the values referring to the equity invested by VCs during each round, fundamental to compute pre-money valuation. Later on, the other databases have been added in order to obtain the missing variables necessary for our analysis. These variables are described in the next chapter 4.

3.2.1 The VICO Dataset

The VICO database is the outcome of the VICO project that seeks to develop a data infrastructure to study how VC impacts on European high-tech sector. The project has been funded by the European Commission within the 7th European Framework Program. Several articles have been already published with the contribution of the VICO database (Bertoni, et al.,2015; Bertoni, et al., 2013). Its first edition has been developed with the grant obtained in 2008, but it has advanced in the subsequent years until the VICO 4.0

was released. The new version shows an upgrade not only in sample size but also in the variety and extent of the information contained.

COMPANIES AND SECTOR

The first database gathered data on both high-tech firms invested and their VC investors. The data were so stored in a time series manner resulting in a panel dataset. The companies were chosen according to three main criteria: younger than 20 years old, running in the high-tech sector and independent from other companies. The sample was picked from seven European countries (Belgium, Finland, France, Germany, Italy, Spain, and the United Kingdom) illustrated in the map shown in Figure 11.



Figure 11 Countries in the first release of VICO

Company Nation	Frequency	Percentage
Belgium	915	10.93%
Finland	760	9.08%
France	1,728	20.65%
Germany	1,340	16.01%
Italy	1,057	12.63%
Spain	876	10.47%
United Kingdom	1,694	20.24%
Total	8,370	100.00%

Table 2 Countries inserted in the VICO dataset

Nonetheless, with the subsequent versions of the dataset, the sample has expanded including firms from other countries contemplating Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom. An illustration of the geographical coverage, together with the distribution of the sample is reported in table 3 and figure 12.

Company Nation	Frequency	Percentage
United Kingdom	5040	27,75%
France	2764	15,22%
Germany	2659	14,64%
Spain	1129	6,22%
Israel	936	5,15%
Finland	863	4,75%
Sweden	792	4,36%
Netherlands	789	4,34%
Italy	592	3,26%
Belgium	441	2,43%
Ireland	434	2,39%
Denmark	381	2,10%
Poland	261	1,44%
Austria	210	1,16%
Portugal	137	0,75%
Hungary	120	0,66%
Bulgaria	119	0,66%
Czech Republic	69	0,38%
Norway	64	0,35%
Latvia	60	0,33%
Lithuania	55	0,30%
Estonia	51	0,28%
Romania	49	0,27%
Luxembourg	36	0,20%
Croatia	30	0,17%
Slovakia	30	0,17%
Greece	27	0,15%
Cyprus	14	0,08%
Slovenia	9	0,05%
Malta	3	0,02%
Switzerland	1	0,01%
Grand Total	18165	100,00%

Table 3 Companies distribution in VICO 4.0



Figure 12 Countries in VICO 4.0

Therefore, the VICO 4.0 dataset contemplates the majority of western European countries. It is particularly relevant that while Israel was not considered in the first version of the dataset, its addition is significant because of the high development of the VC industry in that area. In fact, for every country, the number of companies considered is proportional to the VC industry activity in that area.

DATA COLLECTION

Since the first version of VICO, the data collection has been done locally by 9 research centres: Armines – Ecole des Mines de Paris (France), Politecnico di Milano (Italy), Università Carlo Cattaneo (Italy), Research Institute of the Finnish Economy (Finland), Centre for European Economic Research (Germany), Universidad Complutense de Madrid (Spain), University College London (United Kingdom), Vlerick Leuven Management School (Belgium), Ghent University (Belgium). The data have been verified manually both at the local level by each university and, afterward, at a central level. The information was gathered from public sources and then incorporated with web-based surveys. The sources utilized for companies are Thompson One Private Equity, Zephyr and Crunchbase, which are databases of comparable financial information for public and private companies across Europe, press releases, and websites.

INVESTORS

For the majority of investors, data are provided by VentureXpert, the major database of venture capital and private equity funds data, but a large part of them is integrated with information deriving from annual reports, investor websites, press releases, IPO prospectuses, local and European VC associations. During its development, the number of investors has raised from 1,125 to 7,346 in VICO 4.0. Having an expansion in the number of investors and in the number of ventures affected positively the dimension of the sample of investments.

3.3 Sample construction and descriptive statistics

In this section, we illustrate the steps that mark our empirical analysis. The dataset we refer to is the merged one mentioned in the previous section. It contains 103 observations which refer to 72 different companies, 124 different VCs and 100 investment.

We provide some preliminary insights through descriptive statistics and explain in detail the additional changes made to the dataset to prepare it for the model we have adopted. This means, firstly, to transform the various categorical variables in dummies suitable for the model. Secondly, we transform the single observations related to the VCs, that participated in a specific investment, into means or minimums to collapse them on the specific investment. The model is then described in the next chapter. The descriptive statistics analysis is coherent with our study's objective, looking at investments'

specificities, VCs' characteristics, syndication, geographical distance and entrepreneurs' characteristics.

START-UPS

The Table 4 shows that 36 observations out of 194, corresponding to the 19%, are related to companies founded before 2000, whereas the other 158 observations (81%) refer to companies born after 1999. Almost 25% of the companies observed were born before the first period considered, with the oldest company founded in 1992, the other 75% was founded in the years between 2000 and 2012; consequently, only information after the foundation year is available for these firms. We create dummy variables for every single year in order to include them in our model (*d_year_#*).

Count of CompanyID	Company Founded Year		Grand Total
	Before 2000	From 2000 on	
InvestmentYear			
2000	1		1
2002	1	4	5
2003	1	7	8
2004	8	10	18
2005	5	1	6
2006	2	19	21
2007	3	12	15
2008		17	17
2009	9	9	18
2010	2	12	14
2011		15	15
2012	2	7	9
2013		26	26
2014	2	12	14
2015		7	7
Grand Total	36	158	194

Table 4 Companies per Investment Year

CompanyFoundedYear				
	Percentiles	Smallest		
1%	1992	1992		
5%	1995	1995		
10%	1998	1995	Obs	72
25%	2001	1995	Sum of Wgt.	72
50%	2005		Mean	2004.25
		Largest	Std. Dev.	4.549416
75%	2008	2011		
90%	2010	2011	Variance	20.69718
95%	2011	2012	Skewness	-.4219527
99%	2012	2012	Kurtosis	2.595215

Table 5 Company's founded year

We generate the variable Age_st ³ to compute the age of the company that will be necessary for our regression model.

The dataset includes a variable `CompanyNACERev2Corecodes` that categorises the companies according to a wide variety of business activities. Sometimes they present only slight differences that can be related to three main macro-categories: business activities in manufacturing, research and wholesale. We reduce the range of activities in order to improve our model. Therefore, we create three dummy variables: `Manufacture_st`, `Research_st` and `Wholesale_st`. A high percentage of companies' activities belong to the first two variables that is coherent with the industry under analysis.

Data Panel	Company Business Activity			
	Manufacture_st	Research_st	Wholesale_st	Grand Total
Total	71	113	10	194
Percentage	37%	58%	5%	100%

Table 6 Companies Business Activities

³ The calculation is set as follow: $Age_st = InvestmentYear - CompanyFoundedYear$

The dataset includes observations of companies coming from the European market (including also Israel). In particular, a significant amount is represented by companies coming from United Kingdom (23.2%), Germany (22.7%), Denmark (18%) and France (15.5%).

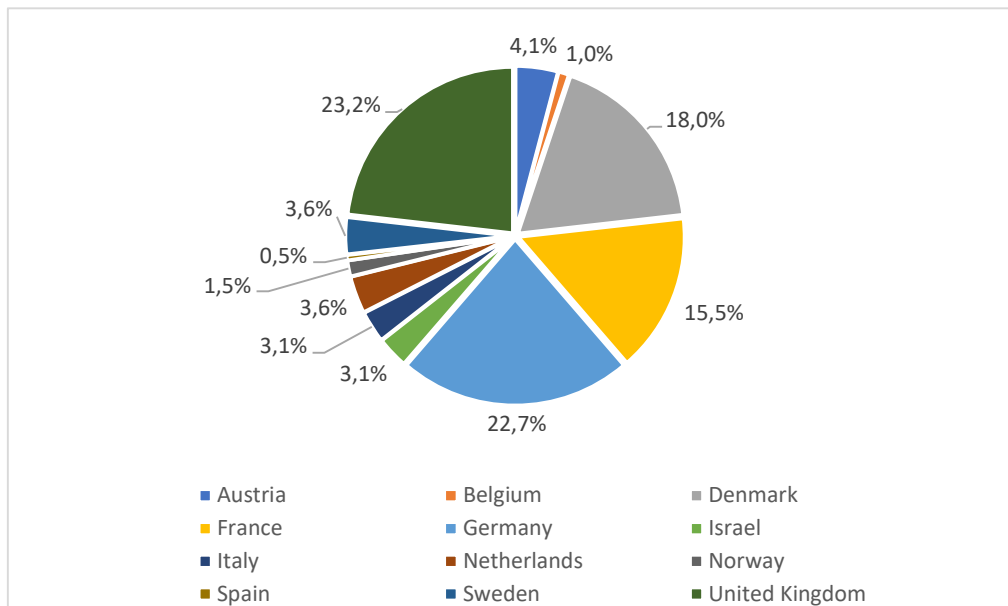


Figure 13 Companies' nations

It is interesting to observe the distribution of the different companies' business activities according to their nation. There is a consistent number of research start-ups in highly innovative countries like Denmark, Germany and UK, whereas in Austria and France manufacture companies are prevalent. Regarding Israel, Italy and Netherlands, even if they are on the edge of innovation, the number of observations is too small to draw conclusions.

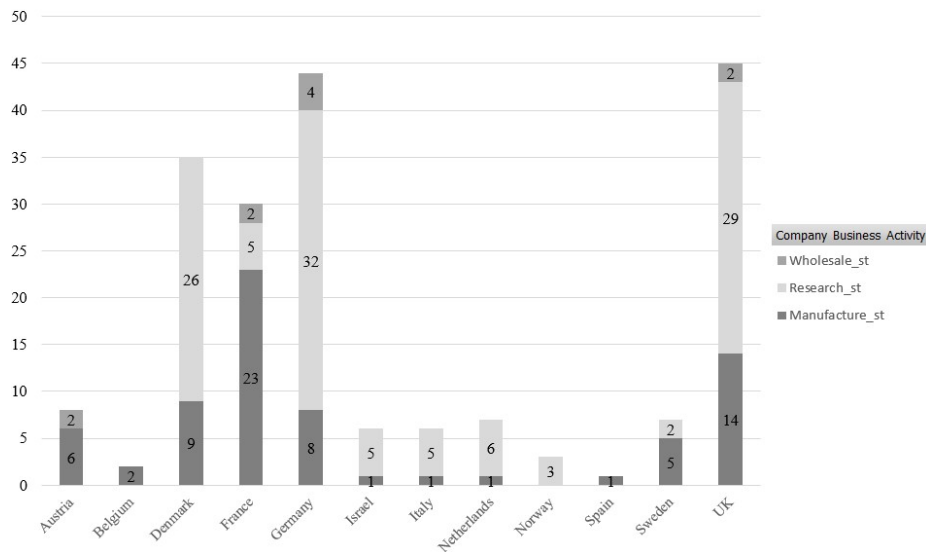


Figure 14 Distribution of Business Activities among nations

Additional information on companies, that regards the financial statements of the company, are obtained by including a supplementary dataset (Orbis). We are provided with the Total Assets, Intangible Assets Ratio⁴, Current Assets Ratio⁵ and Total Debts Ratio⁶ of the companies. In order to prevent potential misleads in our analysis, we considered the data after they have been *winsorized*⁷.

⁴ Intangible Assets Ratio is computed as the fraction of Intangible Assets on Total Assets

⁵ Current Assets Ratio is computed as the fraction of Current Assets on Total Assets

⁶ Total Debts Ratio is computed as the fraction of Total Debts (Total Liabilities) on Total Assets

⁷ “*Winsorized mean*” is a method of averaging that initially replaces the smallest and largest values with the observations closest to them. This is done to limit the effect of abnormal extreme values, or outliers, on the calculation (Investopedia). In our analysis this procedure is applied on the 1% of the highest and lowest values.

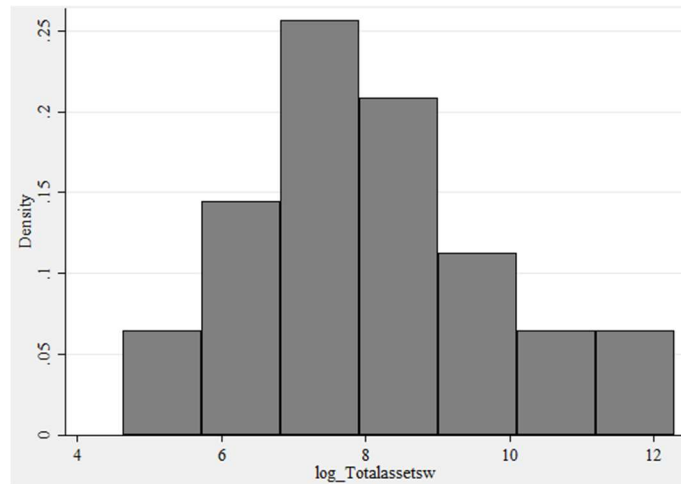


Figure 15 Distribution of log_TotalAssetsw

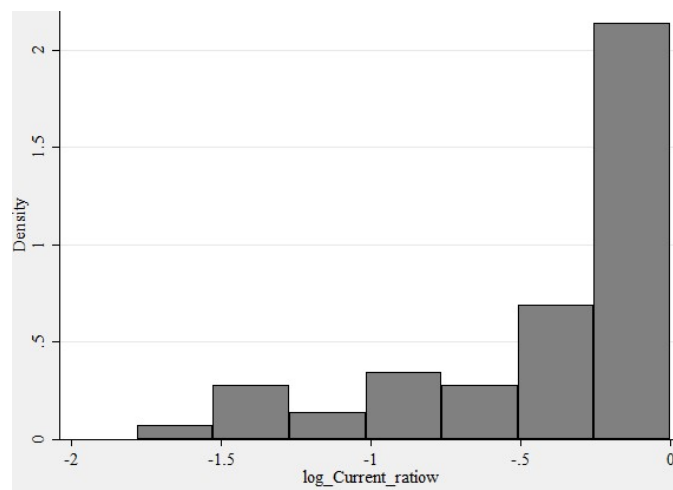


Figure 16 Distribution of log_Current_ratiow

INVESTORS

On the investor side, the dataset contains 5 different types of VC, namely Independent, University, Corporate, Business and Government. Their distributions are different, but equally significant, apart from University VC that represents only 3% of the total.

Investor Type	Total	Percentage
BVC	11	6%
CVC	30	15%
GVC	44	23%
IVC	104	54%
UVC	5	3%
Grand Total	194	100%

Table 7 Investors' Type

We decide to include UVC in GVC. Four dummy variables are created: *IVC*, *GVC*, *BVC* and *CVC*.

The literature states that syndication is a significant element of VCs' deal structure and provides several reasons why VCs syndicate, such as risk reduction, deal flow generation, deal selection and value-adding (Gompers et al, 2016; Jääskeläinen, 2012). Therefore, we create a dummy variable *sindac* to capture this information. It is interesting to observe their distribution according to the start-up age at its first investment received.

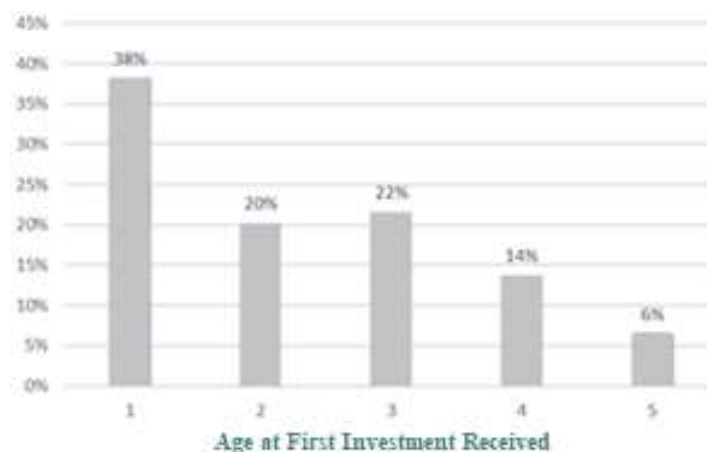


Figure 17 Percentage of syndicated deals according to start-up age at 1 investment

The dataset provides also a description of VCs according to NACER classification. There is a great majority of VCs (89.71%) that are a sub-category of Trusts and Funds and for this reason, are grouped in a single variable. Furthermore, 58 observations lack this description thus it is not considered in our model.

InvestorNACERev2descriptions	Freq.	Percent	Cum.
Manufacture of electronic components ..	1	0.74	0.74
Manufacture of pharmaceutical prepara..	1	0.74	1.47
Manufacture of pharmaceutical prepara..	1	0.74	2.21
Manufacture of pharmaceutical prepara..	2	1.47	3.68
Other financial service activities, e..	3	2.21	5.88
Other monetary intermediation / Trust..	6	4.41	10.29
Trusts, funds and similar financial e..	1	0.74	11.03
Trusts, funds and similar financial e..	104	76.47	87.50
Trusts, funds and similar financial e..	9	6.62	94.12
Trusts, funds and similar financial e..	4	2.94	97.06
Trusts, funds and similar financial e..	2	1.47	98.53
Trusts, funds and similar financial e..	2	1.47	100.00
Total	136	100.00	

Table 8 Investor Descriptions

Including an additional dataset (Thomson Eikon), we can dispose of data related to the experience and reputation of VCs. In particular, for each VC firm we have age, the total number of deals concluded, total estimated equity invested throughout all their

investments made, the total number of companies invested, the capital under management and the number of funds managed. All this information is converted into mean variables in order to consider a single value for each investment. A different approach for age is adopted. We don't consider the mean value but the minimum one (variable `min_Y_inv_founded`), thus the oldest firm of the investment, since in this case the minimum is more relevant to attest the VCs' experience. The logarithmic form is applied as it allows us to deal with better statistical distribution.

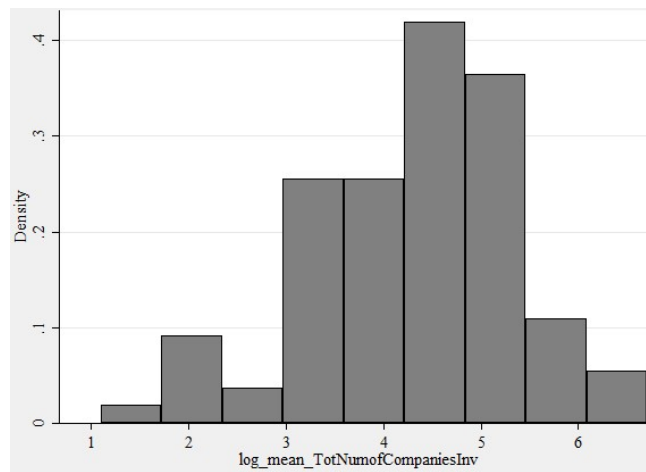


Figure 18 Logarithmic mean of companies invested distribution

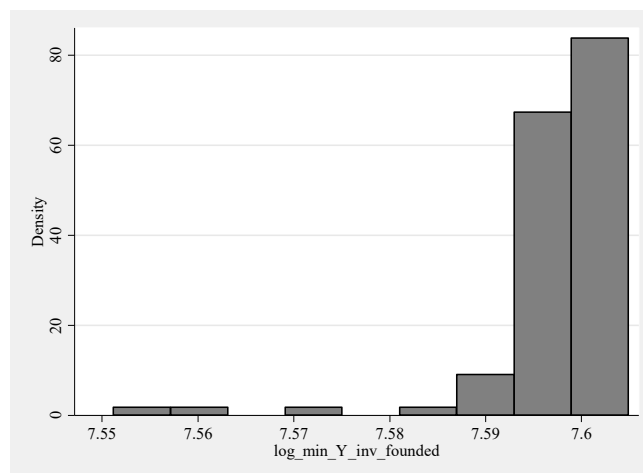


Figure 19 Logarithmic minimum of VC age in the investment

As shown in table 9, the database includes also firms operating in the sector for more than a hundred years (to be considered a huge experience), while a relevant percentage, more than 60%, out of the total of 156, is represented by firms whose foundation can be dated between the 80s and the 90s. Lastly, the newest VC firms, established in the XXI century attest around 20% of the sample.

InvestorFoundedYear				
	Percentiles	Smallest		
1%	1923	1903		
5%	1980	1923		
10%	1988	1945	Obs	156
25%	1994	1972	Sum of Wgt.	156
50%	1998		Mean	1996.064
		Largest	Std. Dev.	12.52233
75%	2001	2008		
90%	2006	2009	Variance	156.8088
95%	2007	2012	Skewness	-4.441052
99%	2012	2012	Kurtosis	29.54231

Table 9 Investor's founded year

The dataset includes also VC firms' geographical information. As expected from investments in the European market, a great majority of the observations are related to firms coming from Europe. Still, there are a small fraction of extra-EU investors (USA and Honk Hong). In particular, a significant amount is represented by investors coming from Germany (24.2%), Denmark (17.5%), United Kingdom (17%) and France (15.5%).

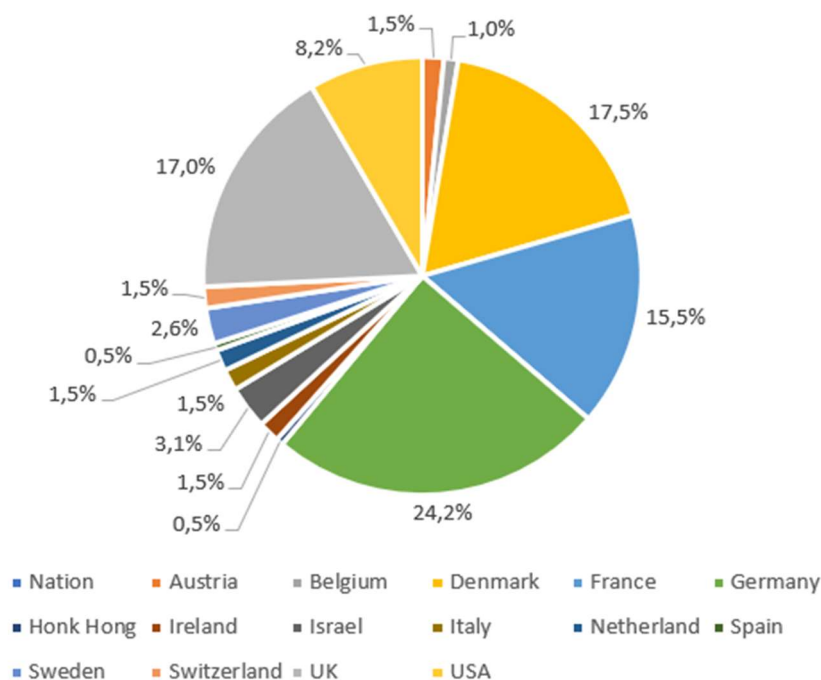


Figure 20 VCs nations

It is interesting to notice that the characteristics of the graph above present some commonalities with the one related to the geographical distribution of the start-ups. We can notice that the 4 most represented nations are again Germany, Denmark, UK and France. This suggests a possible proportionality between the investors and the investees.

The dataset highlights also the presence of investors operating in countries significantly far from the European market such as Honk Hong and USA. We create a dummy variable `d_ext_EU` to test this element. The literature offers many studies that focus their attention on the distance between VCs and start-ups and the differences that exist between European VCs and other VCs (Bengtsson and David, 2009; Kraemer-Eis, 2016; Miralles, 2019). Although we wanted to investigate this effect, investors from Honk Hong and USA represent only 9% of the total, thus not a significant amount to perform a meaningful analysis. A better way to evaluate a potentially significant difference in their valuations

is to consider the information asymmetry generated by the distance between VCs and start-ups. In the dataset are reported the exact position of both start-ups and VC firms expressed according to latitude and longitude. The variables are called respectively CompanyLat and CompanyLong for start-ups and InvestorLat and InvestorLong for VCs. We generate a new variable called distance that is calculated using the Haversine⁸ formula.

The distance of every single investor from the company in the deal is not useful in performing our analysis that does not consider single investors' information. We have to aggregate all the information of the VCs that invested in a start-up during the same round and compute the mean distance for each investment round.

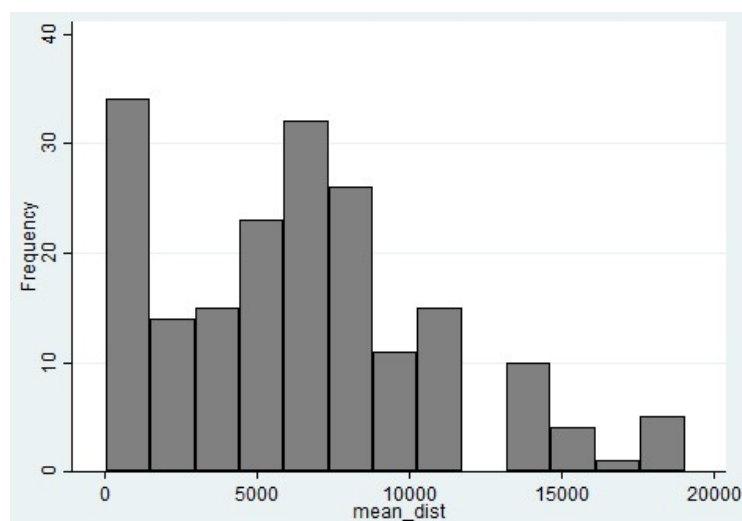


Figure 21 mean_dist distribution

⁸ The Haversine formula utilizes latitudes and longitudes to measure geographic distance d . Given R =the earth's radius (we consider 6372.795 as mean value)
Haversine: $d = R \cdot \cos^{-1}(\sin(Lat_1) \cdot \sin(Lat_2) + \cos(Lat_1) \cdot \cos(Lat_2) \cdot \cos(Long_1 - Long_2))$
 $distance = 6372.795 \cdot \cos^{-1}(\sin(CompanyLat_1) \cdot \sin(InvestorLat_2) + \cos(CompanyLat_1) \cdot \cos(InvestorLat_2) \cdot \cos(CompanyLong_1 - InvestorLong_2))$

We create dummy variables for each nation considered. It is interesting to observe the distribution of the different investors' type according to their nation. The types are proportionally distributed apart from a consistent presence of Independent VC (IVC) in Denmark, UK and USA.

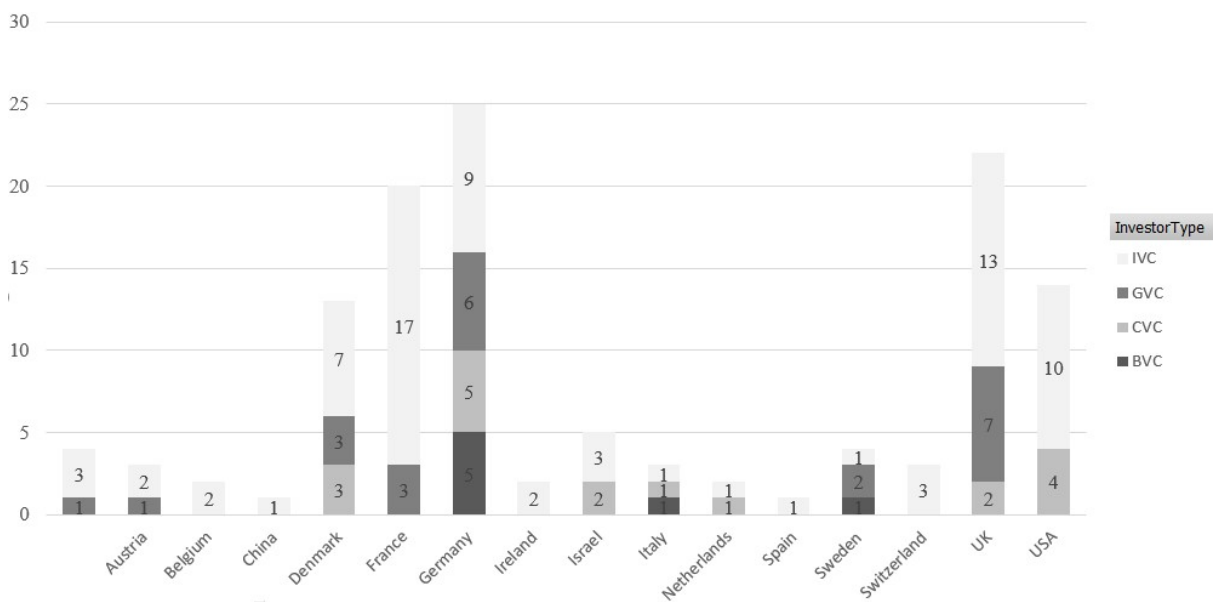


Figure 22 Distribution of VCs' types among nations

In order to be able to use the data in our possession in a way that is useful for the research that we intend to carry out, we still have to reduce the information to have only lines of data belonging to individual investors. Thus, we consider the mean and the maximum of the information related to the VCs. The aim is to obtain several observations that correspond to the number of investments made. This process of collapse reduces the size of the dataset to 103 observations.

As stated above, *pre_money* is the dependent variable of our model. The mean value among 103 observations is 28,229,000 (in the dataset values are reported in K\$) and the standard deviation is 63,999,050.

pre_money					
	Percentiles	Smallest			
1%	28.54651	0			
5%	423.5801	28.54651			
10%	1059.323	234.0844	Obs		103
25%	2501.298	234.3925	Sum of Wgt.		103
50%	4771.289		Mean		28229.8
75%	25915.29	Largest	Std. Dev.		63999.05
90%	65510.23	186902.8	Variance		4.10e+09
95%	109200.6	268098.9	Skewness		4.532281
99%	275914.6	470166.9	Kurtosis		27.17392

Table 10 Pre-money summary statistics

The variable needs to be adjusted, thus we apply the logarithmic transformation and create *log_pre_money*, with an improved distribution, closer to a normal distribution.

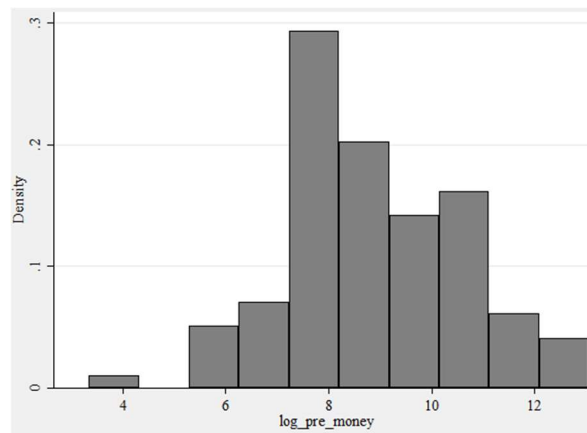


Figure 23 *log_pre_money* distribution

	year 1 (N = 47)	year 2 (N = 21)	year 3 (N = 20)	year 4 (N = 11)	year 5 (N = 4)	Total (N = 103)
Pre-money value (median)	26962	18679	25006	63778	11614	28229
Pre-money value (min)	234	425	28	234	423	28
Pre-money value (max)	275914	98374	106336	470166	38910	470166

Table 11 Pre-money valuations by age at I investment received

Chapter 4. Methodology

4.1 Variables used in the model

In order to test our hypothesis, we develop four different analysis, three of them has the aim of investigating the effect of specific independent variables on pre-money. The last one combines two of the previous analysis, to test their results. These independent variables are related to the education and experience of the entrepreneur and the experience of the investor. The fourth additional analysis is the combination of the variables associated with education and experience to strengthen the previous results emerged. In this section, we describe the dependent variable, the three different sets of independent variables adopted and the control variables common to all regressions.

Name	Category	Type	Description
log_pre_money	Dependent	Continuous	Logarithmic value of the pre-money of any single round
MBA	Independent-Education	Binary	It attests if the founder has attained an MBA
mean_num_Y_ed_manag	Independent - Education	Continuous	It is obtained as the mean of # Y Managerial/ Law that represents the number of years of education in a managerial field
exp_VC	Independent – Experience	Binary	It attests if the founder has prior work experience as VC investor (before the first round of funding)
exp_C_lev_biotech	Independent – Experience	Binary	It attests if the founder has prior work experience as C-level (e.g., CEO, CFO, COO, CSO, etc) in the biotech industry (before the first round of funding)
found_Startup_bio	Independent – Experience	Binary	It attests if the founder has already founded a start-up in the biotech industry (before the first round of funding)
Found_Startup_no_bio	Independent - Experience	Binary	It attests if the founder has already founded a start-up in a no-biotech industry (before the first round of funding)
log_mean_TotNumof CompaniesInv	Independent - Reputation	Continuous	It represents the mean of the total number of companies that each VC firm in the deal has invested in
log_min_Y_inv_founded	Independent - Reputation	Continuous	It refers to the oldest founding year among VC firms that participated in the round
Age_st	Control	Continuous	It refers to the age of the start-up at the time of the investment received
d_year#	Control	Binary	Dummies for every year of foundation (#: from 1 to 15)
Manufacture_st	Control	Binary	It refers to start-ups whose business activities are related to manufacturing
Research_st	Control	Binary	It refers to start-ups whose business activities are related to research
Wholesale_st	Control	Binary	It refers to start-ups whose business activities are related to wholesale

#_st	Control	Binary	Dummies for every country in where a start-up has been founded (#: country)
mean_dist	Control	Continuous	It represents the mean distance between the start-up and its investors in the round of investments
log_TotalAssetsw	Control	Continuous	Logarithmic value of the total assets of the start-up reported in the financial statements
log_Current_ratiow	Control	Continuous	Logarithmic value of the current ratio of the start-up reported in the financial statements

Table 12 Description of variables used in the model

4.2 Research Design

We conduct four different log-linear regressions in order to investigate significant correlations between the independent variables and the pre-money valuation. The independent variables are chosen accordingly to their theoretical influence on valuation, as identified in the literature, and their availability on the dataset.

In line with the previously identified categories of data, the log-linear regressions have the aim to study the effect of entrepreneur characteristics (education and experience) and VC experience on valuation. In the following sections, we describe the different criteria used to select the variables and the motivations behind them. To do that, we show tables picturing the results of Spearman⁹ correlations of variables in the regression models.

⁹ Spearman's correlation measures the strength and direction of monotonic association between two variables. Monotonicity is “less restrictive” than that of a linear relationship. There are two methods to calculate Spearman's correlation depending on whether: (1) your data does not have tied ranks or (2) your data has tied ranks. (Continues in next page)

4.2.1 Education

In the biotech industry, it is very common for companies to have founders with high educational background in technical studies. Biotechnology involves living processes, organisms or systems to manufacture products or technologies intended to improve the quality of human life and to perform specific industrial or manufacturing processes. A start-up in this industry needs to possess high skilled professionals since the beginning. These considerations lead us to exclude all the variables that specify the technical education level of the start-up's founders since considered a prerequisite. We focus instead on the other field of education, thus the one related to management studies. This type of profile seems to be a scarcer resource in the board teams of biotech start-ups and also a more distinctive factor. Our database is provided with all the information about the educational background of the founders. This allows us to study the managerial characteristics of start-ups looking at the education of their founders.

PHD_MANAG (dummy): 1 = the founder has attained a PhD in a managerial field; 0 = otherwise. Fields of study considered as Managerial: Economics, management or political science.

MBA (dummy): 1 = the founder has attained an MBA; 0 = otherwise

The formula for when there are no tied ranks is:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

where d_i = difference in paired ranks and n = number of cases. The formula to use when there are tied ranks is:

$$\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

where i = paired score.

MBA_prestig_uni (dummy) 1 = the founder has attained the MBA in a prestigious university; 0 = otherwise. The university is considered prestigious (for the MBA) if it is included in the top30 2010 MBA QS World ranking.

mean_num_y_ed_manag (continuous): obtained as the mean of # Y Managerial/ Law that represents the number of years of education in a managerial field.

Among these variables, PHD_MANAG does not possess significance because only one company includes a founder who achieved it. For this reason, we decide not to include it in our model.

PHD_MANAG	Freq.	Percent	Cum.
0	85	98.84	98.84
1	1	1.16	100.00
Total	86	100.00	

Table 13 PHD_MANAG distribution

	log_pre_moy	MBA	MBA_prestigi	mean_num_y_ed_manag
log_pre_moy	1.0000			
MBA	0.0307	1.0000		
MBA_prestigi	-0.0826	0.6211*	1.0000	
mean_num_y_ed_manag	-0.0708	0.1225	-0.0748	1.0000

Table 14 Correlation of managerial variables

We investigate the correlation between the variables. It results that, as expected, MBA and MBA in prestigious universities have a significant value of 0.62, which attests a strong correlation. We decide to keep MBA, a more comprehensive variable, and exclude MBA_prestig_uni that, due to its high specificity, excludes almost all the companies in

the sample. Also, we have created a variable `mean_num_y_ed_manag` to express the average number of years of managerial education of professionals in this role who have invested in a specific start-up.

4.2.2 Experience

The previous working background of entrepreneurs is a fundamental factor for the success of the start-up. VCs strongly rely on this non-financial information in order to manage information asymmetries and assess a correct valuation. The literature includes many studies that testify how VCs are willing to pay a higher valuation for companies that possess these entrepreneur's characteristics. In the dataset, we have several variables attesting the professional experience level of the members.

Exp_prof (dummy): 1 = the founder has prior work experience as a professor (before the first round of funding), 0 = otherwise.

Exp_VC (dummy): 1 = the founder has prior work experience as VC investor (before the first round of funding), 0 = otherwise.

Exp_big_pharma (dummy): 1 = the founder has prior work experience in big pharma (before the first round of funding), 0 = otherwise. A company is considered a "big pharma" if it is included in the top 30 of the 2010 ranking of pharmaceutical companies by revenues (downloaded from Orbis database).

Exp_biotech (dummy): 1 = the founder has prior work experience in the biotech industry (before the first round of funding), 0 = otherwise.

Exp_non_biotech (dummy): 1 = the founder has prior work experience in a no-biotech industry (before the first round of funding), 0 = otherwise.

Exp_C_lev_biotech (dummy): 1 = the founder has prior work experience as C-level (e.g., CEO, CFO, COO, CSO...etc) in the biotech industry (before the first round of funding), 0 = otherwise.

Found_Startup_bio (dummy): 1 = the founder has already founded a start-up in the biotech industry (before the first round of funding), 0 = otherwise

Found_Startup_no_bio (dummy): 1 = the founder has already founded a start-up in a no-biotech industry (before the first round of funding), 0 = otherwise.

Work_exp_tech (dummy): 1 = the founder has prior work experience in a technical role in any industry (before the first round of funding), 0 = otherwise.

Work_exp_comm (dummy): 1 = the founder has prior work experience in a commercial role in any industry (before the first round of funding), 0 = otherwise.

Work_exp_finance (dummy): 1 = the founder has prior work experience in a financial role in any industry (before the first round of funding), 0 = otherwise.

Work_exp_manag (dummy): 1 = the founder has prior work experience in a managerial role in any industry (before the first round of funding), 0 = otherwise.

	log_pre_moy	exp_prof	exp_VC	exp_bi_a	exp_bi_h	exp_no_h	exp_C_h	fo_p_bio	fo_o_bio	work_e_h	work_e_m	work_e_e	work_e_g
log_pre_moy	1.0000												
exp_prof	0.1873*	1.0000											
exp_VC	0.0046	0.1464	1.0000										
exp_big_ph_a	0.1820*	0.1161	0.1740	1.0000									
exp_biotech	0.1225	-0.1199	0.1080	0.2632*	1.0000								
exp_non_bi_h	-0.0380	-0.1316	0.6122*	0.0145	0.0120	1.0000							
exp_C_lev_h	0.0119	-0.0549	0.0648	0.0478	0.2832*	-0.0291	1.0000						
found_p_bio	0.2189*	0.0857	0.1136	0.0889	0.4029*	0.0095	0.4031*	1.0000					
found_o_bio	-0.0212	-0.2497*	0.4068*	-0.0802	0.1138	0.4832*	0.1700	0.2673*	1.0000				
work_exp_t_h	0.0672	0.1302	0.1968*	0.2247*	0.3909*	0.2404*	0.1055	0.0684	0.1068	1.0000			
work_exp_c_m	0.0806	0.1240	-0.0056	0.1037	0.0427	0.0796	0.1957*	0.1826*	0.0430	-0.0661	1.0000		
work_exp_f_e	-0.0568	-0.0965	-0.0499	-0.0519	-0.1970*	0.1445	-0.0558	-0.0794	-0.0393	-0.0988	-0.0297	1.0000	
work_exp_m_g	-0.0226	-0.1610	0.2813*	0.2345*	0.3893*	0.3619*	0.3267*	0.0414	0.1968*	0.1974*	0.1105	0.0814	1.0000

Table 15 Correlation of experience variables

Various correlations emerge between several variables; thus, some variables have to be omitted to preserve the consistency of the results of our models. In particular, we exclude `exp_non_biotech` that presents a significant correlation both with `exp_VC` (0.61) and `Found_Startup_no_bio` (0.48). Nonetheless, we need to further reduce the model including only a part of these independent variables. Some reasonings are made in this selection. Previous experience as a professor (`exp_prof`) is excluded from the analysis since there are no references in the literature that indicate it as a relevant factor. The same consideration is done for generic previous working experiences in finance, commercial, technical and managerial (`work_exp_tech`, `work_exp_comm`, `work_exp_finance`, `work_exp_manag`). Then we have three factors that express similar working background: `exp_biotech`, `exp_big_pharma` and `exp_C_lev_biotech`. The first variable, thus a simple previous experience in the biotech sector, does not represent a distinctive factor among the human capital of the different companies. According to our analysis of the literature, the second and the third variables express similar skills and competencies deriving from previous high-level working experience in the sector, thus we keep the previous

experience in biotech as a C-level (CEO, CFO, etc..) thus we do not work with overlapping information.

4.2.3 VCs Experience

Bengtsson and Hsu (2010) show that the personal characteristics of VCs and, not only those of the founders, help to explain the matching between VCs and entrepreneurial firms. The reputation of the VCs, their experience in bringing the portfolio companies to a successful exit and their network with other VCs are important determinants for raising follow-on funds and accessing high-quality deal opportunities (Gompers, 1995; Hochberg et al., 2007; Nahata, 2008). In the dataset, we have several variables attesting the reputation and experience of VC firms.

mean_FirmTotNumofDeals (continuous): mean of the total number of deals that each VC firm in the investment has made.

mean_TotalEstimatedEquityInv (continuous): mean of the total invested equity that each VC firm in the investment has made.

mean_TotalNumberofCompaniesInv (continuous): mean of the total number of companies that each VC firm in the deal has invested in.

mean_FirmCapitalUnderManagement (continuous): mean of the capital under the management of every single firm involved in the specific investment.

mean_NFundsManaged (continuous): mean of the total number of funds under the management of every single firm involved in the specific investment.

min_Y_inv_founded (continuous): the oldest founding year among VC firms that participated in the round

All these variables are transformed into their logarithmic form to adjust their distributions.

	log_pre_m~y	log_me~s	log_me..	log_me..	log_me..	log_me..	log_mi~d
log_pre_m~y	1.0000						
log_mean_F~s	0.2640*	1.0000					
log_me~yInv	0.2699*	0.8915*	1.0000				
log_me~sInv	0.2436*	0.9787*	0.8467*	1.0000			
log_mean_F~t	0.2143*	0.6944*	0.6459*	0.6595*	1.0000		
log_mean_N~d	0.2432*	0.5644*	0.5026*	0.6052*	0.5305*	1.0000	
log_min_Y~d	0.2464*	-0.2010*	-0.1413	-0.2060*	-0.0417	-0.0340	1.0000

Table 16 Correlation of VC experience variables

The correlation table 16 shows significant values for many combinations of variables. The only variable that does not have any relevant correlation is the oldest VC firm in the deal (log_min_Y_inv_founded). Apart from that one, due to the correlation results, our model can contain only one more variable related to reputation. We opt for the number of companies that the firm has invested in (log_mean_TotNumofCompaniesInv). This variable choice is justified since this factor is highlighted as particularly relevant in the literature (Hsu, 2004; Sorenson and Stuart, 2001).

In consideration of our model, we decide to insert the mean number of companies in which the firm has invested and the oldest firm participating in the investment, namely

log_mean_TotalNumberofCompaniesInv and log_min_Y_inv_founded. The choice is made considering that:

- Both the elements are indicated in the literature as credible proxies of VC reputation and experience (Bengtsson and Sensoy, 2011; Gompers, 1996; Hsu, 2004);
- Other variables do not possess necessary observations in order to conduct a relevant analysis or their distribution do not resemble the normal form (neither their logarithmic form).

4.2.4 Control variables

In experimental and observational design and data analysis, the term control variable refers to variables that are not of primary interest (i.e., neither the exposure nor the outcome of interest) and therefore constitute an extraneous or third factor whose influence is to be controlled or eliminated. The term refers to the investigator's desire to estimate an effect, such as a measure of association, of interest that is independent of the influence of the unnecessary variable and free from bias arising from differences between exposure groups in that third variable (control variables). We select within our dataset the variables that correspond to factors that have clearly emerged as relevant in determining the final valuation of VCs. One of the factors is the year when the firm made the investment. In this regard, we use dummy variables that refer to each year from 2000 to 2015 (d_year_#).

We also consider the age of the start-up at the time of the investment received (*Age_st*). Several studies attest that higher age is associate with a greater valuation (Gompers and Lerner, 1999, Nicholson et al., 2005; Seppä, 2003). Another factor that can help influence valuation is the business activity of the biotech start-up that gets a deal. For this reason, in our model, we specify whether the start-up carries out an activity related to manufacturing, research or wholesale. These are three main categories that we built up starting from a wider range of activities provided in the database. The company country is another important element. The study is limited to the European market and it is therefore difficult for important elements concerning cultural distance, such as those studied by Hofstede (2003), to emerge. However, our model must grasp the peculiarities of each nation. Finally, we include the financial information of the companies specifically the data related to total assets and current ratio, both expressed in their logarithmic form. The variables are indicated with a “w” at the end for specification. Among these variables, we select only Total Assets (*log_Totalassetsw*) and Current Assets Ratio (*log_Current_ratiow*). The reasons behind this decision are:

- Both the elements are indicated in the literature as relevant in explaining the pre-money values of VC-backed firms (Hand, 2005; Armstrong et al., 2006; Sievers et al., 2013);
- Other variables do not possess necessary observations in order to conduct a relevant analysis or their distribution do not resemble the normal form (neither their logarithmic form).

4.3 Models

Based on prior research (Gompers and Lerner, 2000; Hand, 2005; Armstrong et al., 2006; Hsu, 2007; Sievers, 2013) we intend to empirically analyse the relative importance of both the characteristics of the start-up and the VC for pre-money valuations. We decide to adopt log-linear models because, respect to linear one, they provide a framework more robust to outliers. This approach is the standard within the current studies on venture valuation (Lerner, 1994; Gompers and Lerner, 2000; Hand, 2005).

We derive four models¹⁰ of interest as follows:

$$\begin{aligned}
 (1) \quad & \text{Log}(\text{PreMoney})_{it} = \alpha_0 + \alpha_n \sum_{a=1}^2 \text{Education}_{it} + \alpha_m \sum_{b=1}^{35} \text{Control}_{it} \\
 (2) \quad & \text{Log}(\text{PreMoney})_{it} = \beta_0 + \beta_l \sum_{c=1}^4 \text{Experience}_{it} + \beta_m \sum_{b=1}^{35} \text{Control}_{it} \\
 (3) \quad & \text{Log}(\text{PreMoney})_{it} = \gamma_0 + \gamma_n \sum_{a=1}^2 \text{Education}_{it} + \gamma_l \sum_{c=1}^4 \text{Experience}_{it} + \\
 & \quad \gamma_m \sum_{b=1}^{35} \text{Control}_{it} \\
 (4) \quad & \text{Log}(\text{PreMoney})_{it} = \delta_0 + \delta_p \sum_{e=1}^2 \text{Experience}_{it} + \delta_m \sum_{b=1}^{35} \text{Control}_{it}
 \end{aligned}$$

Log(Pre-Money) is the natural logarithm of firm i's pre-money value at the investment t. As shown above, we first conduct three separate analyses on the education and experience

¹⁰The coefficients $\alpha_0, \beta_0, \gamma_0, \delta_0$ represent the intercepts.

$\alpha_n, \beta_n, \gamma_n, \delta_n$ are the slope coefficients for each explanatory variable.

of the company's founders (1;2) and on the experience of the VC (4). Then we combine the two models (3) related to the start-up founders' characteristics to confirm the results obtained and to discover previously undetected effects.

Chapter 5. Results

The results presented in this chapter follow the regression models that have been elaborated and shown previously. Since four models have been developed, the presentation of the results follows this logical sequence for a duty of clarity and ease of consultation.

First, we present a univariate analysis of the results that emerged from t Student tests on the selected regression variables in correlation with the pre-money valuation and discuss the most relevant ones.

Secondly, we present the multivariate analysis performed through the four linear regression models explained in section 5.2. In particular, we first show what emerged from the analysis of the effect of education in the human capital and previous industry experience of the start-up's entrepreneurial team on valuation separately. Then, we show

an analysis of the level of education and previous experience that take both factors into account. Finally, we discuss the analysis involving the potential influential effect on valuation resulting from the experience of VC firms accumulated over the years and during the specific activities undertaken. All the results shown are accompanied by a discussion of the statistical data that emerged.

5.1 T-tests

We run several t-tests in order to analyse the single correlations between pre-money and the specific elements included in our model. This approach allows us to disentangle the single effects of the variables from the whole impact generated in the regressions and either confirm or deny the hypothesis made.

First, we consider control variables related to the business activities of the company. In table 17 the test is run with companies operating in the manufacturing sector (variable **Manufacture**). The distribution is balanced, but there is no significant difference between the pre-money means computed.

. ttest pre_money, by(exp_VC)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	71	21756.51	4735.048	39898.22	12312.75	31200.26
1	15	35070.64	14184.98	54938.2	4646.879	65494.4
combined	86	24078.74	4617.828	42823.97	14897.26	33260.22
diff		-13314.13	12154.9		-37485.49	10857.22

diff = mean(0) - mean(1) t = -1.0954
 Ho: diff = 0 degrees of freedom = 84

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.1382 Pr(|T| > |t|) = 0.2765 Pr(T > t) = 0.8618

Table 24 t-test between pre-money and exp_VC

. ttest pre_money, by(exp_C_lev_biotech)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	68	23365.27	5114.579	42175.9	13156.52	33574.01
1	18	26774.09	10926.89	46358.87	3720.363	49827.81
combined	86	24078.74	4617.828	42823.97	14897.26	33260.22
diff		-3408.822	11412.6		-26104.04	19286.39

diff = mean(0) - mean(1) t = -0.2987
 Ho: diff = 0 degrees of freedom = 84

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.3830 Pr(|T| > |t|) = 0.7659 Pr(T > t) = 0.6170

Table 25 t-test between pre-money and exp_C_lev_biotech

. ttest pre_money, by(found_Startup_bio)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	56	17780.61	5407.047	40462.63	6944.649	28616.58
1	30	35835.25	8267.492	45282.92	18926.33	52744.17
combined	86	24078.74	4617.828	42823.97	14897.26	33260.22
diff		-18054.63	9545.409		-37036.73	927.4595

diff = mean(0) - mean(1) t = -1.8914
 Ho: diff = 0 degrees of freedom = 84

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.0310 Pr(|T| > |t|) = 0.0620 Pr(T > t) = 0.9690

Table 26 t-test between pre-money and found_Startup_bio

5.2.1 Education, results and discussions

The first regression model, table 28, is aimed at understanding what is the impact of factors related to the educational level of human capital of start-ups, namely years spent in managerial education and the possession of an MBA, on the pre-money valuation. These factors may attest a good heterogeneity of the team that could be positively interpreted as a signalling factor by investors (Gompers, 2016). It emerges that MBA is not a significant factor to explain an increase in pre-money valuation due to a low level of correlation (p-value: 0.637). The second factor, thus the years spent in managerial studies, presents a p-value of 0.060. This result is in line with our first hypotheses and confirm findings of previous authors that attest a positive correlation with pre-money valuation, even though in our specific case at a low level of significance.

Unexpected and more interesting can be the results obtained for **MBA** variable, which could be valuable trying to understand why MBA and managerial education do not have the same relevance. In our opinion, this difference can be due to the fact that MBA could represent, much more than the managerial education, the presence of a figure in charge of a managerial role. In the case of a person with an MBA we can be pretty sure that he will cover a managerial role within the company, instead, in case of a more general managerial education, this link is not so direct. This figure with an MBA may be the object of skepticism on the part of investors, who prefer to assign a managerial role to people chosen personally by them in order to have better control and to be able to rely on a social network in the industry already consolidated (Roure and Keeley, 1990; Cyr et al, 2000). For this reason, the possible positive effect that having an MBA could have on the

pre-money valuation is balanced and eliminated by this negative one. Finally, among the control variables, **log_Totalassetsw** shows a strong positive correlation with the valuation in accordance with Sievers (2013) who discover that both financial and non-financial information appears to be, on average, complements, since both together have a higher explanatory power. These results are confirmed also by the following models.

EDUCATION	
log_pre-money	P > t /b/se
MBA	0.637 0.385 (0.809)
mean_num_y~g	0.060 0.570* (0.294)
Age_st	0.709 0.060 (0.159)
Manufacture_st	0.715 -1.158 (3.146)
Research_st	0.820 0.525 (2.289)
Wholesale_st	(.) 0.000 (.)
mean_dist	0.820 -0.000 (0.000)
log_Totalassetsw	0.027 0.732** (0.319)
log_Current_ratiow	0.810 (0.789)
Log-Likelihood	-56.808
R-quadro	
N	45

Table 28 Summary of results of I model ¹¹ regression

¹¹ Notes: Model I considers the deal characteristics, the variables selected to attest the level of education in managerial fields proper of the start-up human capital and the complete set of control variables selected both from financial statement and non-financial statement. The dependent variable is the natural log of firm *i*'s pre-money equity value. P-values are estimated using robust standard errors clustered at the firm level (Petersen, 2009).

*The coefficient differs from zero at the 10% level.

**The coefficient differs from zero at the 5% level.

***The coefficient differs from zero at the 1% level.

5.2.2 Experience, results and discussions

The second regression model, table 29, is aimed at understanding what is the impact of factors related to the previous experience of the company team on the pre-money valuation. The factors selected are previous experience VC, experience at C-level (CEO, CFO, CTO...), and entrepreneur background as founder of another biotech start-up or founder of a start-up not belonging to the biotech sector. In our work, we grouped these factors around three hypotheses, each of them connected to a different impact on pre-money that we want to test. It emerges that **exp_VC** (H2c) is negatively correlated with pre-money for a relevant level of significance (p-value: 0.046). This is against our prediction that took into account three factors. A possible high negotiation power of this type of founder, a possible signalling effect due to a relevant pre-existing social network in the industry that the founder is likely to possess from his previous experience and the higher capability in presenting the characteristics of the start-up more appealingly. We try to provide a possible explanation for the result. This kind of experience may have as a main consequence the fact that entrepreneurs with past experience as VC have a better understanding of the potential support associated with a more experienced investor. Therefore, as suggested by Hsu (2004), the entrepreneur would be more willing to accept lower valuation from the investor in exchange for a wider set of added services for start-up development.

The second variable, **exp_C_lev_biotech**, provides values consistent with the hypothesis formulated (H2a). A strong negative correlation with a high level of significance (p-value: 0.032). This enforces our idea that, following what has been said for founders in

possession of an MBA, the existence of an authoritative managerial figure before the agreement with the investors is not seen positively by the VCs. They may have the desire to include a trusted professional and are aware that this type of replacement is unlikely to be accepted smoothly by the start-up's team (Clarysse, 2004; Cyr et al, 2000; Roure and Keeley, 1990).

The third and the fourth variables, **found_Startup_bio** and **found_Startup_no_bio** are selected to test the same effect on valuation. The entrepreneurial background of the founder would suggest a better prospect in the deal sourcing for the investor (H2b). This because with past experience in founding companies the entrepreneur has already acquired huge practical knowledge of the capabilities required to establish a company, the required timing to raise money and to show a profit, how to engage professionals in the activities and how to structure the team and the company. In the case of a founder with previous experience in creating a company in the biotech sector, the knowledge acquired in the same sector enhances, even more, the credibility of the company in the eyes of the VCs.

The consideration is confirmed by the results obtained for what concerns **found_Startup_bio** which shows a strong positive correlation with pre-money with a high level of significance (p-value: 0.038). Quite surprisingly, the same output does not come out from the analysis of **found_Startup_no_bio**. In this case, we have a negative correlation between the variable and pre-money, however with a lower level of significance (p-value: 0.086). A possible explanation for this contradictory result could be divided into two parts. First, as we explained earlier, the fact that the founder possesses previous founding experience in industries different from the biotech means that he has a *generic* knowledge of the start-up environment. Therefore, he does not have the *specific*

capabilities of the biotech sector and this lowers the possible positive effect for valuation. Second, in this analysis we consider the wide range of entrepreneurs that founded a start-up, not in the biotech industry. This is done based on the data present in our dataset, but it does not distinguish between entrepreneurs with a successful founding history and those with a negative one. Therefore, with the data available, there is not the possibility to detect a potentially negative signalling factor from VCs, thus entrepreneurs that proved to fail in leading their start-ups (Gompers, 2010).

EXPERIENCE	
log_pre-money	P > t /b/se
exp_VC	0.046 -2.343** (1.136)
exp_C_lev_biotech	0.032 -1.722** (0.775)
found_Startup_bio	0.038 1.841** (0.857)
found_Startup_no_bio	0.086 -1.671* (0.849)
Age_st	0.906 0.015 (0.128)
Manufacture_st	0.719 -0.927 (2.558)
Research_st	0.541 1.147 (1.858)
Wholesale_st	(.) 0.000 (.)
mean_dist	0.338 -0.000 (0.000)
log_Totalassetsw	0.075 0.562* (0.306)
log_Current_ratiow	0.293 0.811 (0.760)
Log-Likelihood	-47.58
R-Squared	0.836
N	45

Table 29: Summary of results of II model ¹² regression

¹² Notes: Model II considers the deal characteristics, the variables selected to attest the level of previous experience proper of the start-up human capital and the complete set of control variables selected both from financial statement and non-financial statement. The dependent variable is the natural log of firm *i*'s pre-money equity value. P-values are estimated using robust standard errors clustered at the firm level (Petersen, 2009).

*The coefficient differs from zero at the 10% level.

**The coefficient differs from zero at the 5% level.

***The coefficient differs from zero at the 1% level.

5.2.3 Education and Experience, results and discussions

Model III is developed in order to further tests the findings of the model I and II, to strengthen the results obtained for each variable analysed and to discover possible different effects that can arise by considering education and experience together. Looking together at two complementary parts of the human capital of start-ups, such as experience and education, offers an additional and useful approach to study the output of this interaction and its consistency. The model III reveals that the correlation of some factor with pre-money has been confirmed or even strengthened, while others' correlations have lost their significance.

Coherently with model I, considering Education and Experience together does not modify the correlation of **MBA** with pre-money, meaning that even considering the experience of a founder, the fact that he has undertaken an MBA is not relevant for the valuation. For what concern **mean_num_y_ed_manag**, in this case, the positive correlation that already existed passes from having only a low level of significance (p-value. 0.060) to be more relevant (p-level. 0.016). We can say that greater visibility regarding how a general managerial education has developed in real experiences enlarge the understanding of VCs and increases the relevance of the signal in their eyes. Moving to **exp_VC**, the previous founding it is not altered by this test and maintains a coherent high level of significance. **Exp_C_lev_biotech** instead, loses the strong negative correlation highlighted before (p-value: 0.124). This result was not totally unexpected since model III is more complex and takes into account more variables than the two previously analyzed. In addition, we can state that it is not a cause for concern since the sign does not change, the negative

correlation is maintained (coefficient value - 1,243). Similarly, previous experience in founding start-ups from outside the biotech sector (**found_Startup_no_bio**) exhibits a negative correlation with a decreased level of significance, almost negligible. The other factor attesting previous founding experience but in the specific sector of biotech, **found_Startup_bio**, strengthens its positive correlation with pre-money (p-value: 0.020).

To sum up, the additional test provided in Model III shows how the outcomes detected for Education and Experience individually (Model I and Model II) are largely confirmed if we consider the factors jointly. We report slight and not significant variations in the coefficients of correlation. The only remarkable exception is **exp_C_lev_biotech** that loses completely its negative correlation.

EDUCATION & EXPERIENCE	
log_pre-money	P > t /b/se
MBA	0.970 -0.029 0.766
mean_num_y_ed_manag	0.016 0.736** 0.293
exp_VC	0.036 -2.291** (1.052)
exp_C_lev_biotech	0.124 -1.243 (0.791)
found_Startup_bio	0.020 2.046** (0.840)
found_Startup_no_bio	0.097 -1.760* (1.035)
Age_st	0.727 -0.044 (0.126)
Manufacture_st	0.419 -2.402 (2.942)
Research_st	0.937 -0.182 (2.300)
Wholesale_st	(.) 0.000 (.)
mean_dist	0.680 -0.000 (0.000)
log_Totalassetsw	0.011 0.841** (0.314)
log_Current_ratiow	0.105 1.377 (0.828)
Log-Likelihood	-40.37
R-Squared	0.811
N	45

Table 30: Summary of results of III model¹³ regression

¹³ Notes: Model III considers the deal characteristics, the combination of selected variables from Model I and Model II and the complete set of control variables selected both from financial statement and non-financial statement. The dependent variable is the natural log of firm i's pre-money equity value. P-values are estimated using robust standard errors clustered at the firm level (Petersen, 2009).

*The coefficient differs from zero at the 10% level.

**The coefficient differs from zero at the 5% level.

***The coefficient differs from zero at the 1% level.

5.2.4 Experience of VCs, results and discussions

The fourth regression model, table 31, is aimed at understanding what is the impact of factors attesting the experience of the VCs involved in the deal. As explained before, since we want to work with single observations for each investment, the variables considered are means or minimum values elaborated from the array of values belonging to any single investor that participated in the specific investment.

The literature provides us with several factors that can signal the experience of the VC such as its age, its track of investments made, the amount of equity invested and the number of founs managed (Gompers, 1996; Sorenson and Stuart, 2001). Among these factors, we select the age of the investor, meant as the age of the oldest VC participating in the investment round and the number of firms invested, meant as the mean of the number of companies in which the VCs have invested.

These variables have been selected because considered as the best available alternative within the dataset in our possess. They were both used as proxies for the quality of the deal and the potential positive support that the VC can deliver to the start-up, fastening its growth.

The results are in contrast with our expectations as formulated in the hypothesis: VCs with considerable experience could offer lower valuations due to their reputation and the additional services provided (Hsu, 2004). **Log_mean_TotNumofCompanies** shows a positive correlation with pre-money even if with a low level of significance (p-value: 0.064), while the positive correlation exhibited by **log_min_Y_inv_founded** is statistically even stronger (p-value: 0.003).

A possible explanation for these unexpected results could be a scenario in which the more experienced VCs, thanks to their status, have signed deals with the most promising start-ups and therefore with the best prospects. Although we control for some financial performance of the company in the model, we cannot exclude that other unobserved company characteristics (such as the patent stock or better management team) drive our results. Below the regression panel of table 31, we provide a brief sub-chapter where we test this possible explanation by looking at the interaction effect of the experience of VC and the previous experience of the founder in the creation of other biotech start-ups.

VC EXPERIENCE	
log_pre-money	P > t /b/se
log_mean_TotNumofCompaniesInv	0.064 0.652* (0.340)
log_min_Y_inv_founded	0.003 84.577*** (26.898)
Age_st	0.097 0.137* (0.080)
Manufacture_st	0.022 3.104** (1.291)
Research_st	0.013 3.069** (1.174)
Wholesale_st	(.) 0.000 (.)
mean_dist	0.120 -0.001 (0.000)
log_Totalassetsw	0.037 0.490** (0.226)
log_Current_ratiow	0.276 -0.374 (0.338)
Log-Likelihood	-45.25
R-Squared	0.825
N	43

Table 31: Summary of results IV model¹⁴ regression

¹⁴ Notes: Model I considers the deal characteristics and the variables selected to attest the level of education in managerial fields proper of the start-up human capital and the complete set of control variables selected both from financial statement and non-financial statement. The dependent variable is the natural log of firm i's pre-money equity value. P-values are estimated using robust standard errors clustered at the firm level (Petersen, 2009).

*The coefficient differs from zero at the 10% level.

**The coefficient differs from zero at the 5% level.

***The coefficient differs from zero at the 1% level.

INVESTIGATING UNEXPECTED RESULTS

This section aims to provide quantitative data to support a potential explanation for the unexpected positive results that emerged from the regression of model IV. The analysis clearly shows how, as the experience of VC increases, the corresponding valuation in the deal is higher contradicting what presented by Hsu (2004). Therefore, it surges the need to better understand the dynamics behind this process, which may involve specific interactions between the variables considered. These interactions can produce effects that are very challenging to be interpreted from the regression tables. So, we have to test whether the positive and unexpected results we obtained in the IV model can be generalized or only applies in some cases.

We hypothesize that the more experienced VCs, thanks to their status, can sign deals with the most promising start-ups and therefore with the best prospects. This idea suggests conducting a study on a possible interaction of variables representing the VC experience and the ones reflecting the start-up promising profile. The multiplied effect of these variables offers the opportunity to get new insights into the Model IV regression panel.

In order to produce this further control, we select the best available proxies for these two aspects. On one side, **found_Startup_bio** is chosen as the best available proxy of the start-up quality and probabilities of success, while, on the other side, we create a dummy variable **VC_EXP** from the total number of companies the VC has invested in, to attest the level of the VC experience. Working with a dummy variable allows us to produce a better analysis than with a continuous one, so we assign **EXP_VC** = 1 when **log_mean_TotNumofCompaniesInv** is higher than 4 and **EXP_VC** = 0 when lower.

The selected value corresponds approximately to the value 55, figure 24, the means of the total number of companies the VC has invested in. Thus, based on the distribution of the averages of the companies in which VCs had invested in, we selected 55 as the threshold that distinguishes between experienced and less experienced VCs. The final outcome, in table 32, highlight how 30 VCs are considered of great experience (**EXP_VC = 1**) and 73 not (**EXP_VC = 0**).

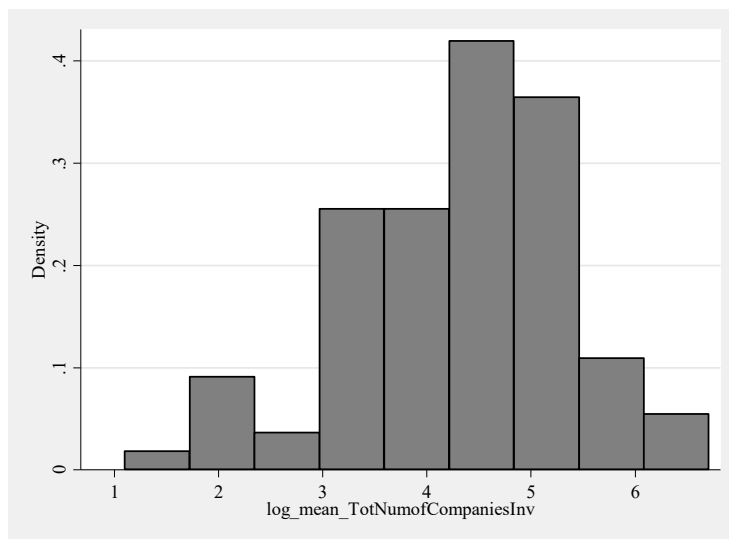


Figure 24 *log_mean_TotNumofCompaniesInv* distribution

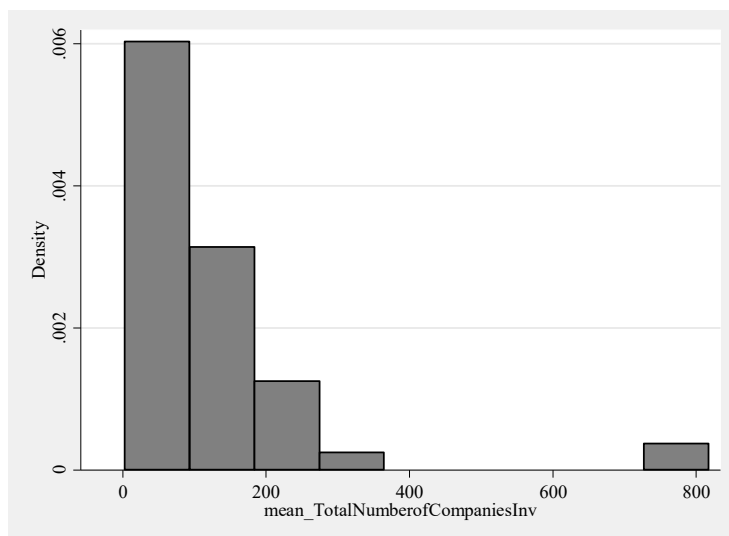


Figure 25 *mean_TotalNumberOfCompaniesInv* distribution

```
. tab EXP_VC
```

EXP_VC	Freq.	Percent	Cum.
0	73	70.87	70.87
1	30	29.13	100.00
Total	103	100.00	

Table 32 Distribution of EXP_VC

We study the interaction between **founder_Startup_bio** and **EXP_VC** and it emerges that when the founder actually has previous experience as founder of other biotech companies, having a more experienced investor increases the valuation (p-value: 0.074). The same is not demonstrated in the case of an experienced VC that signs an agreement with a start-up that does not have founders with these characteristics (p-value: 0.822). In conclusion, the additional control seems to support our hypothesis that a positive correlation between pre-money and VC experience can be sustained only when the interaction happens between experienced investors and start-ups with high expectations of growth and probability of success.

```
Average marginal effects          Number of obs   =      45
Model VCE      : Robust

Expression   : Linear prediction, predict()
dy/dx w.r.t. : 1.EXP_VC

1._at       : found_Startup_bio=      0
2._at       : found_Startup_bio=      1
```

	Delta-method				
	dy/dx	Std. Err.	t	P> t	[95% Conf. Interval]
1. EXP_VC					
_at					
1	.1996837	.8796198	0.23	0.822	-1.581014 1.980381
2	-1.940695	1.055337	-1.84	0.074	-4.077113 .1957226

Note: dy/dx for factor levels is the discrete change from the base level.

Variables that uniquely identify margins: found_Startup_bio

Table 33 VC experience impact on valuation if found_Startup_bio present

Chapter 6. Conclusions

6.1 Summary of the results

This study aims at analysing some of the relevant elements that can impact on the pre-money valuation of a start-up. The necessity of implementing this kind of research derives from the attempt to tackle the issue of information asymmetry, thus, the idea that different actors embedded in a transaction have an unbalanced knowledge. A possible solution to this phenomenon is given by signalling theory which explains how it is possible to reduce the inability of one party to easily and effortlessly access information of the other one. In fact, the theory suggests that actors involved in the transaction can provide specific factors that attest their quality and that are, therefore, recognizable by the other party. In the

contingent case of start-ups, they are new entities in the marketplace and do not possess an observable track record that the VCs can exploit as a criterion to manage their investment decisions, so, they have to base their decision evaluating other signals.

From the pre-existing considerations in literature, we have therefore decided to deepen this research field with respect to the work of Hsu (2004), Hand (2004; 2005), Armstrong (2006) and Sievers (2013). Our analysis focuses on how the different characteristics of start-ups and VCs influence the different stages of financing, with particular attention to the early stages of the pre-money valuation. Moreover, we focused on the biotech world, in line with what previously done by Hand, in both his studies, but shifting from the US market to the European one. Thanks to the possibility to access the VICO, Orbis, LinkedIn and Thomson Eikon databases we were able to build a detailed and complete overview of the economical/ entrepreneurial dynamics of the area.

We took into consideration the works of the above-mentioned authors and include in our research the descriptive framework of VC-Start-ups interactions, developed by Kohn (2018) that furthers the understanding of the determinants and their relationships regarding start-up valuations in the VC context. This integrative framework conceptualizes that start-up valuations in the VC context are determined by a three-sided interplay of the determinants related to start-ups, VCs, and the external environment. Fundamental for our research is the evidence that both start-ups and VCs characteristics impact on the pre-money valuation of start-ups and the start-ups-VCs matching. Signals that a start-up can deliver to the VCs, to facilitate the valuation can be of two different natures: financial and non-financial. Referring to the pre-money valuation of start-ups in their early stages, the literature presents two different beliefs. Hand (2005) states that financial and non-financial characteristics are substitutes in valuation since the

importance of financial information increases as the start-up grows where instead the relevance of the non-financial one follows the opposite trend. Sievers (2013) argued the Hand's (2005) findings demonstrating that the two factors combined are complementary in assessing a more accurate valuation, one increasing the explanatory power of the other. From the pre-existing considerations in the literature, we decided to deepen the impact of non-financial characteristics of a start-up keeping the financial information as control variables to free our models from undesired bias and influences. We wanted to test if the human capital of the start-up and the type of education and experience of the founders' team could have a relevant impact on the pre-money valuation. Moreover, we know from the literature that it is not only the investor that selects the start-up but also the entrepreneur that chooses the VCs (Cumming et al. 2012; Hsu, 2004; Sahlman, 1997). As regard how start-ups evaluate the different offers, the value-added activities performed by VCs are not only related to providing companies with financial resources but, instead, to offer them a range of service and skills, among which one of the most important is their management expertise. In general, we can say that the main services offered by VCs include business recommendations, extensive mentoring, financial support, striking strategic alliances and recruiting senior executive managers. In order to understand the final pre-money valuation is not enough to consider exclusively the financial offer of VCs, but it is needed to take into account a wider range of factors. For this reason, in doing our analysis, we considered relevant the reputation of the investors and their experience in bringing start-ups to successful exit, keeping the start-up characteristics fixed.

Starting from the expected direct positive effect of the founders' education on the pre-money valuation, the study has analysed how specific entrepreneurs' characteristics

influence the amount of money invested in a start-up. In particular, we have supposed a positive impact that the presence of an entrepreneurial team member with an MBA or managerial education may have on VCs' valuation (H1).

As a further step, to investigate the impact of the founders' working experience on the pre-money valuation different determinants have been analysed. Firstly, we expected start-ups that have top-tier-manager with previous experience in the biotech industry as chief managers to be penalized (H2a), resulting in lower valuation or even dissuading VCs to invest. Secondly, starting from the distinction between generic and specific components of human capital theorized by Becker (1975) we expected in both cases to have a positive impact on the pre-money valuation. Therefore, we expected that the presence of a founder with previous experience as founder of a start-up, in both the biotech and non-biotech industry, increase VCs' valuation of a start-up (H2b). Thirdly, we believed relevant to understand the impact of an entrepreneurial team member with a previous VC experience could have on the pre-money valuation: according to our theoretical analysis, we expected a positive effect (H2c). Leaving the start-up's perspective and moving to VCs' one, we aimed at proving the negative impact that the VCs' experience may have on the pre-money valuation. The investors' experience is evaluated in terms of age and companies invested and the expectation is the higher the experience the lower the valuation accepted by start-ups (H3).

Four analysis have been carried out in order to test the formulated hypothesis. Table 34 summarizes the results obtained with the different econometric model, providing a clear overview of the hypothesis that has been confirmed and of those that have not.

Model	Hypothesis	Results
Model I	<i>(H1) The presence of an entrepreneurial team member with an MBA or managerial education has a positive effect on the pre-money valuation.</i>	<i>MBA does not present correlation with pre-money, while years of study in managerial education has a positive correlation for a low significance (p-value: 0.060)</i>
Model II	<i>(H2a) The presence of a founder, with previous experience as a top-tier manager in the same industry, of the focal start-up has a negative effect on the pre-money valuation.</i>	<i>exp_C_lev_biotech has a negative correlation with pre-money for a high level of significance (p-value:0.032)</i>
	<i>(H2b) The presence of a founder with previous experience as founder of a start-up, in both biotech and non-biotech, has a positive effect on the pre-money valuation.</i>	<i>found_Startup_bio has a positive correlation with pre-money for a high level of significance (p-value: 0.038), while found_Startup_no_bio has a negative correlation for a low level of significance (p-value: 0.086)</i>
	<i>(H2c) The presences of an entrepreneurial member with a previous VC experience has a positive effect on the pre-money valuation.</i>	<i>exp_VC has a negative correlation with pre-money for a high level of significance (p-value:0.046)</i>
Model III	<i>The hypothesis of model I and II are confirmed and strengthened by their combination.</i>	<i>MBA still not relevant, found_Startup_bio, found_Startup_no_bio and exp_VC confirm the previous findings, years of study in managerial education increase its relevance (p-value:0,016) and exp_C_lev_biotech (p-value: 0,124) loses any relevance.</i>
Model IV	<i>(H3) The VC experience in terms of companies invested and his age have a negative effect on the pre-money valuation.</i>	<i>Age has a positive correlation with pre-money for a high level of significance (p-value:0.003), while the number of companies has a positive correlation for a low level of significance (p-value: 0.064)</i>

Table 34 Results summary

Starting from the educational background of the founders interesting and meaningful results are obtained. In line with our first hypothesis, it emerged that the presence of an entrepreneurial team member with a managerial education has a positive effect on the pre-money valuation.

Even if until today no scholars have deeply investigated the managerial education background of the entrepreneurial team and its possible impact on VCs valuation, through model I, we are able to confirm our initial assumptions. Knowing the positive impact that a heterogeneous team has on the valuation (Bantel, 1993; Milliken and Martins, 1996; Tihanyi et al., 2000; Wiersema and Bantel, 1992) and the fact that is very common for start-ups in the biotech industry having founders with a high educational background in technical studies (Prevezer, 2001), we speculated that the factor that is differential in VCs valuation is the managerial learning. Our hypothesis was not totally correct because the positive correlation with pre-money was not validated in case of the presence of an MBA. Even if, at first, this result surprised us, by better looking in the studies previously carried out we found a reasonable explanation. In the case of a person with an MBA, it is easily implied that he will cover a managerial role within the company, while in case of a more general managerial education the link is not direct. We know (Roure and Keeley, 1990; Cyr et al, 2000) that VCs sometimes prefer to personally choose and assign high managerial roles within the company to experienced managers and not to founders. They are looking for better control over the company to increase its probability of success, by leveraging on their already consolidated social network. In this case, our findings have been confirmed through model III that provides us with the same result of the model I.

For what concern experience the results of models II and III have small discrepancies.

In formulating our second hypothesis (H2a) we decided to go partially against the results of the majority of the previous studies which widely testifies that, especially in science-based sectors, entrepreneurs that acquired significant expertise in the incumbent industry are more likely to succeed in their new ventures. This decision was taken consciously, with the aim of testing if the effect detected in the first model for people with an MBA was present also for those founders with previous experiences as C-level. Model II confirmed our supposition, supporting the idea that the existence of an authoritative managerial figure before the deal is not seen positively by VCs. They generally have the desire to include a trusted professional, aware of the fact that this type of replacement is unlikely to be accepted smoothly by the different members of the company. Model III, instead, does not highlight the same finding. This result was not completely unexpected since this model takes into account a greater number of variables, both related to experience and education. Moreover, since the variable loses its significance but not the sign, this is not a big concern.

In testing the effect that the presence of a founder who already has experience in founding a start-up in the same or different industry, we were expecting in both cases an increase in the pre-money valuation of VCs. In general, we can say that this reduces VCs uncertainty (Hsu, 2004a) and increases the chances of start-ups to success (Sievers et al., 2013), as the founder, even before having a consistent positive result, is perceived as an expert and trustable. Our expectation has been partially confirmed by model II. As regards the experience in the biotech industry, the positive correlation is also strong, while, for serial founders in other industries the correlation is negative, even if with a low level of significance. These results have been also confirmed by model III and, in our opinion, this can have two possible motivations. First of all, adapting our particular case to what

found by Becker (1975), the founder's generic knowledge of the start-up environment is the one he developed during his previous founding experience in the non-biotech industry. Therefore, he may not have the specific capabilities of the biotech sector. For this reason, we believe that it is plausible that the mere presence of general knowledge is not sufficient to have a positive impact on the pre-money valuation and rather, it is poorly viewed by the VCs which offer a lower price. Second, the negative impact can be due also to the fact that, with the data available, it is not possible to distinguish between successful and unsuccessful start-ups' founders.

Lastly, as far as the founders' experience is concerned, we decided to study something totally new. Several reasons, such as a greater negotiation ability and network and understanding of the relevant signals for VCs, led us to think that the presence of a founder with previous experience as a VCs could have a positive impact on pre-money. Both our models (II and III) did not confirm our assumptions. Indeed, the negative correlation can be explained and motivated by combining two factors: founders with VC experience have a better understanding of the potential non-monetary benefits that VCs can give to start-ups and, according to Hsu (2004), they will be willing to accept lower valuation in exchange to be associated to highly reputable investors.

As concerns the last model (IV), as previously affirmed, the idea was to study the VC's perspective and not the startup's one. We were expecting a negative correlation between the experience of the VC and the pre-money valuation. As we know from the literature, entrepreneurs are willing to accept lower valuation in order to be associated with more experienced investors and their potential higher value-adding services (Hsu, 2004). Against our hypothesis, model IV outlined the opposite effect, a positive correlation between VCs' experience and private valuation. We tried to provide a possible

explanation for it, supposing that more experienced VCs are more likely to sign deals with the most promising start-ups. We tested this theory by selecting the variable `found_Startup_bio` as a proxy for the start-up's quality and we create a new dummy variable `EXP_VC` to be used as a proxy of VC experience. We investigated potential multiplied effects generated by their interaction. It emerged that, if it is true that experienced VCs assign higher valuations to entrepreneurs with previous founding experience in biotech, the same is not validated when entrepreneurs lack this particular previous experience. This test contributes to sustain our supposition.

6.2 Limitations

This study tried to evaluate the effects that the characteristics, of both start-ups and VCs, have on the pre-money valuation. Our intention was an attempt to fill a gap that emerged in the literature.

Even if the results of the proposed work are consistent and some of the hypotheses formulated have been confirmed, the research has some limits, which is correct to point out.

In explaining the limits of our research, we decide to divide them into two categories: elements that have limited our possibility to investigate other variables of interest and elements that have limited the understanding of the results of models.

Starting from the first category we can say that the VICO database comes from one of the largest projects of data collection in Europe related to VC investments, including a

significant number of companies. However, the database in our possession does not present sufficient completeness to develop a deeper analysis that could have embraced a higher number of observations among both companies and VCs.

For our research, the estimation of the pre-money valuation¹⁵ was fundamental. Unfortunately, many observations related to investment rounds do not provide all the values of the quota¹⁶ of the single investors and/ or the total equity associated with the round. Observations refer to a timeframe of fifteen years, between 2000 and 2015 and, especially for the first part of the twenty-first century, was not very common for start-ups to publicly record in a structured way the percentage of the company obtained by a single investor through his investment. For this reason, we were not able to find these missing data in any, both public and private, databases, restricting significantly the observations in the model compared to the dimension of the whole dataset (moving from 73,217 to 194 observations).

As previously explained, in order to perform our analysis, we needed to merge the VICO database with three other datasets. For example, in merging VICO with Orbis, further limitations emerged; a large amount of start-ups' accounting values were missed, this had a big impact on our research. It has conditioned our methodology, both in the process of selecting financial variables, limiting the number of the ones available to be used and in the decision process regarding the possible analyses to be carried out. A very similar issue comes from the combination of the VICO database and the Thomson Eikon one related

¹⁵ $PreMoney = Valuation - Total_Equity_invested$

$$Valuation = \frac{Total_Equity_invested}{(Quota_to^{16})/100}$$

¹⁶ Quota_tot is computed as the sum of the quotas of every investor in the same investment round.

to proxies of VCs' reputation. In the Thomson Eikon's dataset several variables attesting the reputation and experience of VC firms are included, but, after the merge, we witnessed such a heavy loss of observations that prevent us from conducting a relevant analysis.

Moving to the second category, the missing information about the founding history of the entrepreneurs is another relevant constraint coming from the database. It means that, with the available data, is not possible to distinguish whether founders that have already founded a start-up have been successful in doing that or not. Having this information would have certainly supported us in better understanding the results regarding hypothesis 2a.

Moreover, referring to missing data again, the availability of information about the following years of start-up development, in terms of exit¹⁷, could strengthen our supposition in commenting the results of model IV.

More in general, leaving the two above mentioned categories, we point out a limitation linked to the regionality of the analysis. This study takes into account what happens in the European start-ups context, therefore, it is not possible to directly conclude that the deductions drawn from this research are valid also in other regions, where different variables may be more or less relevant due to diverse cultural contexts and to a different historical development of the VCs-start-ups ecosystem.

In conclusion, it is important to remark that our study does not consider the valuation methodology utilized by the different VCs involved in the investment rounds. However, even if we cannot arrange the information about the methodology applied (missing

¹⁷ Business exit strategies include IPOs, acquisitions, or buy-outs but may also include strategic default or bankruptcy to exit a failing company.

information), we control the different factors that influence the investment risk, such as country of origin and stage of the investment.

6.3 Further research

Many possible future research lines may be originated to answer and solve the limitations that this study implies and that have just been presented. Our study aimed at analysing how the founders' background and the experience of the VCs impacted on the pre-money valuation. We decide to keep constant the characteristics of one party when analysing the other but, due to the limited number of observations, we were unable to study the joint effect of the two factors. It could, therefore, be very interesting for future researchers to investigate the effect that different configurations of experience and education of the start-up's founders and experience of the VCs together, influence the pre-money valuation. Taking into consideration all the different forces allow us to provide a broader overview of their different effects. In particular, having proper and complete data on VCs, future work could investigate the probability of formation of ties between investors and start-ups, varying the level of VCs' reputation (i.e. experience and exit performance) and start-up's entrepreneurial team quality.

Moreover, the same research may be conducted on a different sample of VC-backed firms. A sample coming from a different area (US or Asian markets), that refers to a different time period or different industries (high-tech, fintech, healthcare, energy) can be used to test if the same results are replicated in a different context.

Another indication for subsequent works could be to use different proxies for the categories investigated (education and experience of the founders and experience of the VCs) that offer a similar, nonetheless different, perspective in order to verify and reinforce what has been found in our models. More in detail, focusing on what emerged from the t-tests conducted with single independent variable and pre-money, we were unable to further investigate relevant outcomes that emerged. We decided not to take into consideration the difference in pre-money valuation that existed between European investors and USA/ HKG investors because the observations we had were non sufficient. However, as the t-test highlighted a strong correlation it can be of particular interest to deepen this topic, taking as a reference the study conducted by GP Bullhound (2016) that focused on unicorns and shows that in Europe they are valued 18 times their revenue while in US they are valued 46 times.

A further and more detailed investigation should be done also on the results that emerged in the t-test involving the pre-money and the presence of a syndicate. Deals between start-ups and single investors proved to be connected with a higher valuation than the one involving syndication. Such a contradictory result should require specific analysis to test if it belongs to casualty or it due to a not yet investigated causes.

Moreover, another possible extension of our study may be related to the investigation of the impact on pre-money valuation of specific types of VCs or syndications (e.g. IVC+CVC or IVC+GVC or IVC alone). Even if the initial dataset provided this information, we decided not to use it as discriminants in our research. Finally, our study focused only on pre-money valuation in early stages, future studies could highlight the variation of the determinants between various investment phases, like, for example, start-ups vs scaling stages.

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