POLITECNICO DI TORINO

Corso di Laurea Magistrale
in Ingegneria Gestionale
(Engineering and Management)

Tesi di Laurea Magistrale

Diversification strategies in Venture Capitals Investments

Effects of syndication on AI start-ups

Relatore
prof. Luigi BENFRATELLO

Candidato
Antonio MOSCHELLA

Anno Accademico 2019/2020

Index

1. Introduction

The technological development of innovative products or services over the decades has been taken in charge more and more by independent entrepreneurs. The so-called start-ups are small firms that undertake the development of risky, complex, but potentially revolutionary projects. The undeniable contribution of start-ups to the innovation development is sometimes slowed down by the structure of the financial markets. Those companies are generally specialised in the operational processes but lack of organizational, managerial skills as well as financial resources. The high level of risk associated to such companies precludes the possibility of securing traditional bank loan. To financially support the start-ups that otherwise would not have access to additional monetary resources a set of financial intermediaries takes the responsibility of addressing this funding gap. Between them the most active in the market are the venture capitals, which are usually limited companies that gather capital from third parties and allocate them in funds made of equity shares of start-up companies.

Given the high risk associated to the firms that compose the venture capitals' funds it should be a primary concern of the fund managers the reduction of the overall exposure. The most recognised methodology to achieve the adequate risk-reward balance, as dictated by several traditional financial theories, is the diversification. Research literature on venture capital investments recognises two main approaches to the business subdividing them into specialised and generalists. The first are typically inclined to finance start-ups of the same industry or developing similar products. Whereas, generalist venture capitals build funds with different start-ups belonging to various sectors. Despite the mix of industries included in a given portfolio, the researches showed that there are other variables over which the fund manager can act in order to diversify away specific risk. In fact, even specialised venture capitalists may apply a diversification approach to their business. An important study on the subject matter has been conducted by Matusik and Fitza (2012) in their article *Diversification in the venture capital industry: leveraging knowledge under uncertainty*. The study revealed a u-shaped relationship between diversification and returns, suggesting that benefits come with low diversification, in other words specialising, or with high diversification, thanks to the risk reduction effects.

The results of Matusik and Fitza analysis are coherent with the double role assumed by venture capitalists and the double point of view of their investment decision-making. Besides being a financier of start-ups, the venture capitalist plays an active role in the post-investment phases. The deals in this market are not traditional loans, they are rather a purchase of company equity. For this reason, after the investment phase the investor becomes part of the shareholders and therefore directly interested in the success of the portfolio company. Logically the venture capital will make available its management skills to support the growth of the company value, in order to exit the deal and eventually make a profit out of it. Therefore, the double role considers the venture capital as both an investor and a manager. These motives put the diversification strategies constantly in contrast between the benefits of diversified portfolios

with heterogeneous firms and the increased complexity in the management phase that derives from it.

In this context there is a strategy applied by several venture capitals that fosters diversification and eases the management of multiple companies. As exhibited by many researches a common practice among venture capitalists is to co-invest through the establishment of syndicated partnerships with other peers. The majority of the literature on the subject matter has been focusing on the effects of syndication during the selection phase. The possibility of sharing the process of venture selection with a second point of view is of great value, assumed the high asymmetries of information in the start-up environment. Usually of ten start-ups financed only one will result in a successful exit, while the others do not achieve the results expected at the time of financing. However, it has been demonstrated that there are other determinants of syndication besides superior venture selection (Lockett and Wright, 2001). The formation of a co-investment deal surely helps each investor to distribute the capital resources over a larger number of firms and to share the risk with the partners. Given this understanding the syndication appears to be strictly linked to the diversification of venture capitals as it helps achieving benefits through both the risk reduction effects and the efficient joint management of the companies.

This thesis focuses on the latter aspect and considers syndication as a strategy for diversification. Starting from the understanding that syndication provides the venture capitalist with a set of tools that allow greater diversification and therefore better portfolio optimization. It has been conducted an empirical analysis on a dataset of European start-ups developing AI technologies. The latter fits well for the analysis as the field of artificial intelligence is emerging and growing in the last decades. The high uncertainty relative to the development of the AI technologies entails a high level of risk. Making predictions about future performance and practical applications is extremely hard in the early stages. Being the venture capitals mostly active in the initial phases of the companies the sample under analysis fits well for the hypothesis testing regarding syndication effects. The purpose of the thesis is to collect the main results of the previous literature, from which to formulate hypothesis over the syndication dynamics and effects.

In the second chapter it is presented the venture capitals and innovation financing environment. To draft an overview over the players involved in the business to be analysed it is provided a description of the venture capitals and the other alternative sources of finance. It is described the differences in the business models and their interactions with the entrepreneurial companies. Then it is showed the specificities of the various stages of development of the innovative firms, along with the differences in the relationships with investors along the growth.

The third chapter analyses the venture capital cycle, describing the most common practices along the stages, from fundraising until the exit. The parallelism with diversification and the determinants of investment decision making is traced along each stage. It is showed a summary of the most popular theories about diversification belonging to the traditional portfolio theory. Then the concepts are applied and interpreted in the context of venture capital investments. It is therefore, described a set of strategies put in place in order to diversify the funds with a

detailed focus on the syndication practices. In each subparagraph it is reviewed the relative literature of the topic.

Chapter four introduces the methodologies of the analysis. It is described the sample that has been used and how the available data was organised. It defines the entities and attributes used to represent the market and its players. The descriptive statistics about such entities provide a set of insights about the AI development environment.

Chapter five is dedicated to the analysis conducted on the dataset and the discussion of the results along with suggestion for future studies.

2. The venture capitals framework

The next few paragraphs mean to frame the Venture Capitals' industry in the historical, competitive and economic context in order to prepare the knowledge ground for the study. Understanding causes and effects of venture capitals investments and portfolio companies' structure might be an important issue to be addressed to frame the research objective.

The ties that connect innovative firms and venture capitals are much more complex than a relationship between a bank and the borrower. Venture Capitals are also a trusted companion and mentoring coach to all the brave entrepreneurs that aim to disrupt markets and industries again and again. Through the years all the so-called radical innovations, that left a mark as generation milestones of technologies, were in the first place supported by visionary venture capitalists. From microprocessors to biotech tools Venture Capital investments have always looked towards the future and beyond mere returns on capital. Their role as innovation promoters is widely recognised by the society and the economic environment. The results of many studies demonstrate that venture capital financing helps reducing dramatically the average time to market of a product and that each dollar of investments is three times more efficient in stimulating patenting than a dollar on traditional Research and Development (R&D) (Gompers and Lerner, 2001). Furthermore, positive impacts on local employment are a natural consequence of the growth of entrepreneurial activities, which are able to secure jobs for the community if there is a solid financial structure in the background. Understanding the importance of the role played by high growth firms in the overall economy, it is not of secondary concern to have a complete view on the dynamics of the venture capital firms that sustain them and in the cause-effect chain that connects investors strategic decision making to portfolio companies performance.

It will be initially given a definition of venture capital firm along with a schematic overview on the fund's governance structure. Then it is introduced the complex of similar structures involved in analogous investment activities which in a broader conception could be considered competitors of venture capitals. It will be described what are the main differences with the venture capital business model and their interactions with the start-ups. These other types of investors are commonly known as alternative financing sources, because their supply of financial resources fill a funding gap in the economic environment. In this regard, it will be then showed the parallelism between stages of company's growth and the investment behaviour of such financial intermediaries.

The chapter's overview on venture capitals and innovation financing culminates with a brief paragraph on the main historical events that accompanied the journey of venture capitals and start-ups from the post war years until today.

2.1 Venture capitals definition

There is no unique definition of venture capital firms. The structure and the functioning of such funds changed through the decades since the establishment of the very first venture capital funds in the 1940s. This evolution will be explained in further detail in paragraph 2.4.

The European Private Equity and Venture Capital Association (EVCA), renamed in 2015 Invest Europe, provides the following definition:

> Venture capital is a type of private equity typically invested in entrepreneurial, innovative businesses to help them grow. Crucially, as well as funding, venture capitalists offer tailored support for your company, from refining strategy and helping commercialise innovation, through to new product and service development and bringing your business onto the global circuit.

Venture capitals funds differ from each other for many characteristics and have different approaches to the market, however, the most part of them seems to follow the same common aspects summarised in the following few points:

a) They are basically structured as private equity funds. Institutional investors provide capital resources that are allocated by the fund managers and used to buy stakes in private companies. Usually are committed with a long-term perspective, often between 7 and 10 years. There is a subtle difference, however, between conventional definition of private equity and venture capitals that will be explored in depth in paragraph 2.2.2.
b) The spectrum of their investments is composed of small private firms. Venture capitals allocate their financial resources on high-risk portfolio companies that generally should compose only the 10% of one's portfolio. In effect, venture capitalists focus on the middle part of the classic industry S-curve. They avoid both the early stages, when technologies are uncertain and market needs are unknown, and the later stages when competitive shakeouts and consolidations are inevitable and growth rates slow dramatically (Zider, 1998). The timing and the stages of venture capital investing will be explored in paragraph 2.3.
c) The value added to the portfolio company goes beyond the financial resources. Since the venture capitalist is not providing a loan but buys shares of the company instead, it is its own personal interest the future success of the entrepreneurial idea. Therefore, the contribution is not only quantifiable in monetary terms because venture capitalists provide managerial, technical and strategic aid. A brilliant young entrepreneur might have the most revolutionary idea but lacking the abilities to exploit its full potential successfully bringing it to the market.

Lastly venture capitalist may have a generalist or a focused approach in their investment strategy. Generalists deal with a range of various industries whereas industry focused venture capitalists tend to populate their funds with companies belonging to the same industry. Those belonging to the second category leverage on their deep knowledge of the industry to select carefully the investments and to effectively help to enhance their operations, for example venture capitals specialised in biotech investments are usually focus oriented. However, this strategy seems to give a certain degree of bias towards the same risk factors that the same

industry may face. Therefore, the purpose of this thesis is also to investigate the diversification strategies put in place by industry focused funds and their impacts on the risk exposure and growth of the portfolio company.

2.1.1 Venture capitalists' profile

The venture capitalist is the professional figure who manages directly the venture fund. It is the one in charge of allocating third parties' financial resources and supplying the know-how to the portfolio companies. Because of the active role to be played in the company in which it has been decided to invest in, the preferred academic path of venture capitalists is science oriented. Engineers, researchers in biotechnologies and digital sciences are the most suitable profiles, because of their knowledge of the industry, even more than professional with banking background or MBA graduates.

On the personality side a venture capitalist should appear charismatic and goal oriented. A magnetic character like Elon Musk, who's able to attract interest and confidence on every new entrepreneurial idea he decides to back. The ideal venture capitalist should be able to quickly grasp potentialities of growth and give the entrepreneurs access to his established network of affiliations (clients, suppliers, consultants, other investors etc.).

The majority of the literature on the subject matter emphasizes the benefits of the value added by the venture capitalist. It makes sense to think that a contribution of know-how and expertise would indeed result into a win-win deal. The entrepreneur receives both financial and managerial resources that his business needs to grow exponentially, the venture capitalist instead benefits from this growth in order to make profits whenever he is ready to sell the equity stakes. However, it is not always so bright the relationship between investors and entrepreneurs and the effects of a success cannot always be attributed to the operating value added. It is hard to say whether a successful venture capital backed start-up would have achieved the same result without the managerial help given by the investor. It is not the purpose of this thesis, but perhaps understanding the real impacts on profitability of the diversification of the portfolio of companies would entail a reconsideration of the allocation strategies given also the evidences of the uncertain effects of the know-how contribution.

A recent study aimed at exposing uncertainties on venture capital summarises the inefficiencies of the model in two points. Firstly, most venture capitalists lack real-life business operating experience. Writing checks against investment proposals is a relatively effortless activity when compared to making value-added contributions to an entrepreneurial firm post-deal closure. This lack of operating experience negatively impacts the extent to which venture capitalists can meaningfully add value to entrepreneurial activities. Secondly, venture capitalists are time constrained by their often-self-imposed organizational constructs and structures; they are simultaneously involved in deal identification, due diligence, and negotiating new investment projects while participating in their existing investee firms (not to mention fundraising initiatives). Venture capitalists are normally expected to participate on the board of directors of two to four investee firms at any one time in addition to processing between one to two new deals per annum. Experience suggests that most venture capitalists rarely find sufficient time

to review the investee firm's quarterly reports ahead of board meetings. The trade-off involved with simultaneously negotiating new and existing deals may often represent a "zero-sum" game for venture capitalists—the more time they dedicate to searching for and processing new deals, the less time they effectively have for value-adding interactions and contributions. Research indicates that, on average, venture capitalists spend about ten hours per month with one investee firm, this roughly equates to one day per month per investee firm. (Klonowski, 2018). The criticality of this time-fund size trade-off is worth to be analysed deeper. Venture capital partners are pushed to manage always bigger fund to increase both the returns and their probability. The larger is the amount of money to be managed, however, the less is the time that they can dedicate to the single portfolio company. Obviously, the more time is dedicated to improving the portfolio company's operation the higher is the probability of achieving the successful exit. Therefore, differentiation and fund's size should be calibrated with respect to the availability of resources that the venture capital can offer, otherwise the results could damage both sides.

2.1.2 Fund's structure

Venture capital funds are often structured in the shape of limited partnerships. Usually the contract of partnership agreement is signed including a predetermined maturity date. On average a venture capital fund has a life cycle between 7 and 10 years.

The reason why many decide to structure the fund around limited partnership agreements is the benefit of duties and responsibilities separation between the parties involved. This category of contracts is stipulated between more individuals who jointly perform a business activity, providing goods, capital and know-how, with the intention of sharing the profits. In the case of venture capitals, the fund pools capital from investors but fund managers directly oversee the whole investment process. It is their duty to screen and select the potential game changers, controlling and guiding the companies' growth and eventually make profits from the exit. The legal framework establishes a separation between the ones providing the money and the ones managing it. Such separation is likewise evident in the profits and losses distribution.

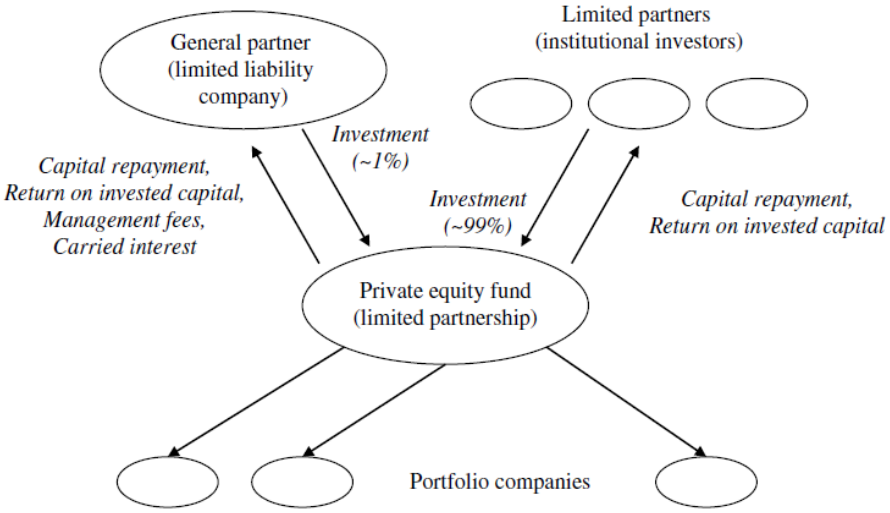
The main actors interacting in a limited partnership are, therefore, the limited partners, the general partners and the portfolio companies. Limited partners renounce to possibility to actively and directly manage the fund in exchange for limited liability. In fact, they act as passive investors, providing the capital that is put in the hand of the fund managers. Limited partners enter, effectively, into a relationship contract with the general partners in which they buy their management and investment practice. The benefit they receive in delegating such activities is the limited liability that is indeed restricted to the amount of capital provided, not beyond. Limited partners are usually high net worth individuals, but on average they are represented by institutional investors such as pension funds, endowments, insurance companies or other investment funds. Limited investors are often moved by diversification needs, attracted by the potential above the average returns or simply interested in the investment opportunities that otherwise might be inaccessible.

As already mentioned, the business activities are directly carried on by the general partners or fund managers. They are the linking piece that connects investors to the investees. Their role is strictly related to the needs of both counterparties and their job would not exist without the other two. Given the exitance of a limited partnership agreement between the investors, the fund managers might as well be structured by themselves in a limited liability company. The latter refers to the internal organization of the fund, with respect to the limited partners they have a full liability to repay the investment. For this reason, the interests of all the parties are completely aligned. General partners are compensated with a management fee, usually around 2% of the committed capital, and have residual claims on profits once the limited partners have been repaid. In this framework the portfolio companies which receive the investment money in exchange for equity stakes will be also supported and encouraged towards a rapid growth so that their value increases, the management company successfully liquidates the equity and the limited partners receive the investment back along with the profits. It is not uncommon also for the general partners to invest their own wealth in the portfolio companies, thus increasing their exposure to risk and aligning even more their interests to the other parties.

The portfolio companies in which the fund managers invest the money committed by limited partners are just the end of the chain. *Figure 2.1* gives a schematic look over the mutual relationships between the parties and proves that investment in the fund is significantly pledged by the limited partners, holding on average 99% of the equity stakes.

Figure 2.1

Limited partnership funds' structure



Source: Pierre-Yves Mathonet, Thomas Meyer - J-Curve Exposure_ Managing a Portfolio of Venture Capital and Private Equity Funds (The Wiley Finance Series) (2008)

2.2 Alternative sources of finance

The business of financial investments is a large field of study, constituted by several different types of approaches, special cases and exceptions. All the monetary funds that daily are invested

either in public markets or via private agreements add fuel to the expansion and consolidation of many industries. Financial investments are not a privilege of the big players, who can secure collaboration with banks due to the size of their business. For this reason, a whole set of entrepreneurial investors which does not buy shares of companies listed in public markets but rather negotiates contracts directly with the entrepreneurs, which prefer a potentially high growth asset rather than a liquid short-term investment. Entrepreneurial finance is not merely speculation, but value creation instead, especially addressed to smaller firms or even embryonic state start-ups. The so-called sector of private equity is an essential outcome of many determinants. From the viewpoint of the rookie entrepreneur at a certain point there will be a need of an amount of money higher than what family and friends can provide, but in an early stage of growth such that, bank loans are inaccessible. Thus, private equity is a necessary to complete the capitals' cycle that brings money to every new generation of entrepreneurial firms.

In this paragraph it will be initially addressed the difference with the definition of private equity that often leads to misunderstandings. To complete the overview on the alternative sources of funding the main categories will be explored in detail individually. It will be drafted an overview on the other approaches to the same kind of investments of venture capitals such as business angels, business incubators, crowdfunding and then the hybrid cases of corporate venture capitals.

2.2.1 Funding gap

Venture Capitalism exists as a result of capital market structure and regulations. Laws prohibit Banks and investments funds of applying interest rates on loans above a certain threshold, that, otherwise, would result into usury. For this reason, entrepreneurs funding start-ups would not have access to any kind of external financing. In fact, the interest rate applied would be extremely high to reflect the high risk and the frequent absence of hard assets to be offered as a collateral. The risk is associated to the impossibility to make realistic assumptions over future performance, because the outflows of operating expenses are unclear, market size and level of penetration has not been tested yet. This is mostly frequent in the technological and pharmaceutical industries. For example, pharmaceutical industry research and development, usually requires large investments in terms of money and time before the revenues start to pay back the efforts of a long series of clinical trials.

Where the banks cannot provide financing and the internal resources are not enough there is a gap that restrains entrepreneurial firms from growing. For the most promising projects that gap is filed by business angels, venture capitals and the other players that are willing to accept the risky bet.

2.2.2 Differences with private equity definition

Venture capital and private equity are often mistaken as synonyms or used inappropriately. This paragraph aims at drawing a thin but explanatory boundary line between the two. From an institutional point of view, private equity is the provision of capital and management expertise given to companies to create value and, consequently, generate big capital gains after the deal.

Usually, the holding period of these investments is defined as medium or long (Caselli e Negri, 2018). Private equity consists therefore in all the speculative investments aimed at purchasing equity stakes of private companies, therefore, not listed in stock exchange markets. The definition of private equity encloses a wide range of different types of business that, described in detail, would outline the whole financial structure of contemporary finance. The main features of private investments that greatly influence the behaviour of its managers are determined by price, liquidity and monitoring. Price is not driven by market fluctuation but by negotiation and due diligence instead. While public equity can be immediately liquidated in market exchanges, a private equity share needs to be sold to another investor to be found autonomously. Lastly the regulators and governments oversee public companies whereas the private equity agreement is enforced by ad hoc contracts signed by the investor and the prior shareholders. As already mentioned, negotiation ad later collaboration between the parties establishes a close relationship, which is a peculiar characteristic of private equity deals, given also the fact that the shareholders composition is altered.

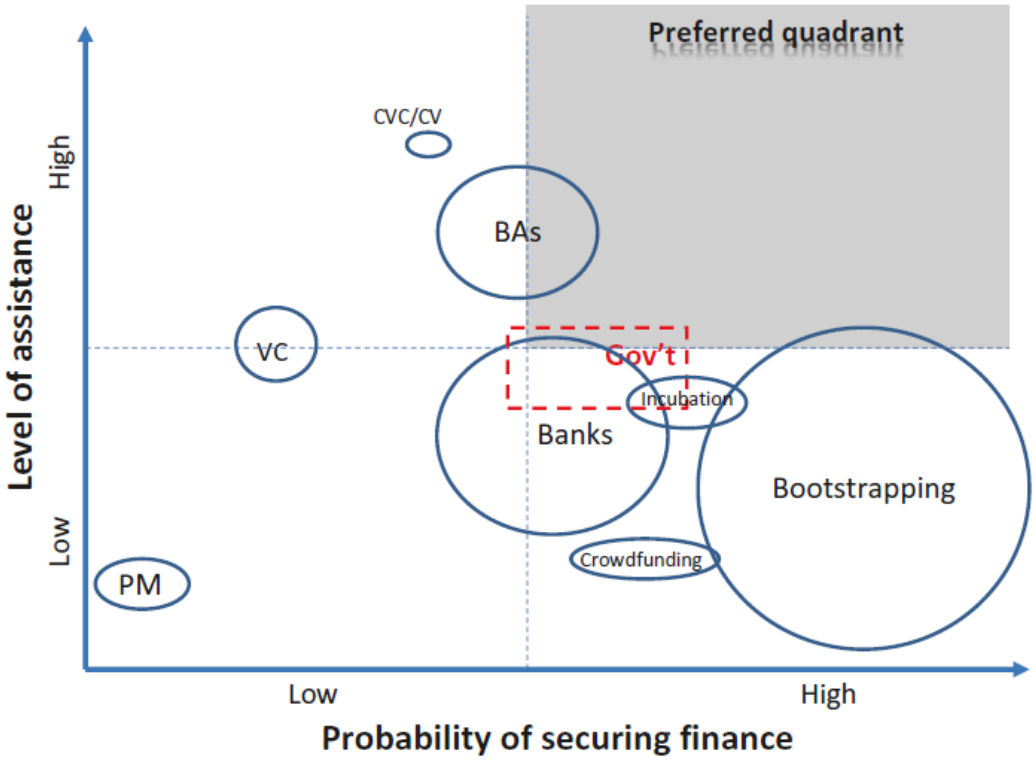
Given the widespread range of the private equity sphere, venture capital can be considered a subset included within the larger one. According to the characteristics described in the previous paragraphs venture capitals constitute that fraction of private equity investing in high-risk with potential high growth perspectives entrepreneurial ideas. In fact, the funding takes place in the early stages of the company, usually when the product or service is not marketed yet. Therefore, entrepreneurs attempting to expand and develop their innovative idea address to venture capitals whose strategy is typically funding in the early stages, whereas more mature companies will be financially supported by private equity firms. The relationship between funding and the firm's stages of growth will be analysed in paragraph 2.3.

2.2.3 Taxonomies of alternative finance

The graph in *figure 2.2* compares the venture capitals industry with the other alternative finance providers but also banks, Governments and bootstrapping. The various financing alternatives have been framed in a graph with the horizontal axis measuring the probability of securing capital from the investors an on the vertical axis the level of assistance beyond money received. The size of the bubbles reflects the size of the market available to each source. Many studies and surveys have demonstrated that bootstrapping is the most common practice used to raise capital. The term "bootstrapping" relates to the use of internal resources of the firm to generate cash. It is the most common because it has the benefit of building a sustainable business from the very beginning, however it suits only the entrepreneurial projects that needs little support from external entities.

Figure 2.2

The universe of entrepreneurial financing options



Abbreviations: VC venture capital, CVC/CV corporate venture capital/corporate venturing, BAs business angels, PM public markets, Gov't government assistance programs

Source: Darek Klonowski, The Venture Capital Deformation Value Destruction throughout the Investment Process, Palgrave Macmillan (2018)

Venture capital is an alternative providing a medium level of assistance however, as reflected by the reduced size of the bubble, it is challenging for the start-ups to convince them to fund their idea. Because of this difficulty in getting in the good graces of the fund managers it may seem a sub optimal choice, but some extremely efficient venture capital can be located closer to the preferred quadrant.

2.2.3.1 Business Angels

Business angels are wealthy individuals who invest their own financial resources in private potentially high-growth companies. Just like venture capitals they seek for the potentially successful capital gains investing in young innovative companies. There are a lot of similarities, given also the same investor-manager approach, but here is a substantial difference in many aspects.

Business angels have, on average, €470,000 available for investment. The median is very similar, and only very few investors declared themselves able to allocate €2 million to investments. Most angels have an investment capacity that ranges from of between €60,000 to and €300,000. Angels would ideally invest an average of €100,000 in a single project (José et al.,2004). Their investments are, therefore, focused on smaller entrepreneurial projects to which they access through their network of connections. Investing their own wealth, business angels have a higher risk appetite with respect to venture capitals that professionally manage third parties' funds.

Another difference is in the different stages of the company growth in which the investment occurs. Business angels' financial help is usually focused on very early stages of companies, when they still carry the start-up label. Liquidity availability of individual investors is by definition inferior to the one of structured funds. For this reason, business angels support is for sure helpful at the very beginning but at a certain point the entrepreneurs might need larger investments to speed up research, buy assets and marketing services that wealthy individuals might not be able to secure. This difference between the maximum amounts the business angels are able to invest, and the minimum amount for which venture financing is meaningful, creates an 'equity gap' for early stage companies. Depending on economic conditions, venture capitalists move towards later stage investments, thus increasing this gap to somewhere between €2 million to €5 million. Theoretically the cooperation between business angels and venture capitalists could help to reduce the equity gap (Mathonet and Meyer, 2008).

2.2.3.2 Business incubators

Business incubators, similarly to business angels, are active on the early stage firms and sometimes are a connection hub for start-ups seeking for angels' investments. The range of services offered by these institutions is larger compared to the other types of investors in private equity. Their support to the young entrepreneurs goes far beyond the financial resources. Legal, marketing and accounting services, training and mentoring activities, intellectual property management are just the main benefits that start-ups get from incubators. The proximity of the workspaces with other entrepreneurs is a benefit itself. It helps fostering cooperation, networking, exchange of opinions and idea generation.

The physical location of such business development centres is frequently very close to areas with a high density of other active businesses and industries. It is also highly frequent to find incubators within the walls of university campus, so that cooperation with the academic environment is tighter and the mutual benefits higher.

It is also common to find the term accelerators, to differentiate those incubators providing similar services but focusing on later stages firms. Their role is, therefore, to accelerate growth of business and market expansion.

2.2.3.3 Crowdfunding

Crowdfunding is the alternative financing method that involves the higher number of investors. It consists in raising small contributions from a large number of individuals to fund small projects or businesses. The process of connecting the proposer of the project and the public is often mediated by an internet platform. Through such digital tools geographical barriers have been demolished allowing and easing the diffusion of the ideas. Entrepreneurs can pitch their venture simply uploading a brief video. This feature is aligned with the recent trends of internationalization of venture capitals' investments, mainly aimed at diversifying the portfolio delocalizing investments and reducing the local bias.

Crowdfunding campaign have proven to be popular with artistic, creative and social oriented projects. Personal interests and passions play a vital role in driving these types of investments, most of the times even more that the financial prospects. The investor receives claims over the potential future profits along with the feeling of participating on the creation of value for the community. For the latter reason many projects are small local campaigns that attract the interest of potential recipients of the project's value. Along with the social responsibly gratification there is the stimulus from individual passions. In the late 1990s the online crowdfunding campaigns, even before the term was coined, began to gain popularity in the music community with massive donations from fan groups.

2.2.3.4 Corporate venture capital

The Business Dictionary defines it as the practice where a large firm takes an equity stake in (or enters into a joint venture arrangement with) a small but innovative or specialist firm, to which it may also provide management and marketing expertise. The objective is to gain a specific competitive advantage. It is not a synonym of venture capital, there is not a fund management third party linking the firms. Corporate venture capital is most of the times considered an alternative to internal R&D instead. A larger firm buys stakes in smaller start-ups in the hope of creating a mutual benefit with the capital injection. For this reason, the definitions use the word strategic. It is a way for companies to plan a medium-long term investment which is aimed at keeping the pace of the innovation cycles, so usually it targets a technology development, a new market opportunity or exclusive resources and capabilities.

While venture capitals investment goal is set on the exit and the related profits, corporate venture capital has a different philosophy aimed at keeping the value created. Financial returns are not the primary and only motivation, the strategic advantage achievable by acquiring the smaller entrepreneurial company bring more value than the monetary gains on the investments. The two objectives are not in conflict between themselves, as demonstrated by Dell Inc. whose investments in smaller software companies were initially planned to look for profits but eventually the companies that ended up being acquired provided valuable patents and intellectual property.

For the strategic reason of the investment, corporate venture capital needs an additional decision-making step when evaluating a potential portfolio company. The parent company needs to foresee the possibility to integrate the start-up within the established business

organisation. Therefore, it must be considered the compatibility with the company's resources, routines, distribution channels, brand and corporate culture.

2.3 Stages of equity investments

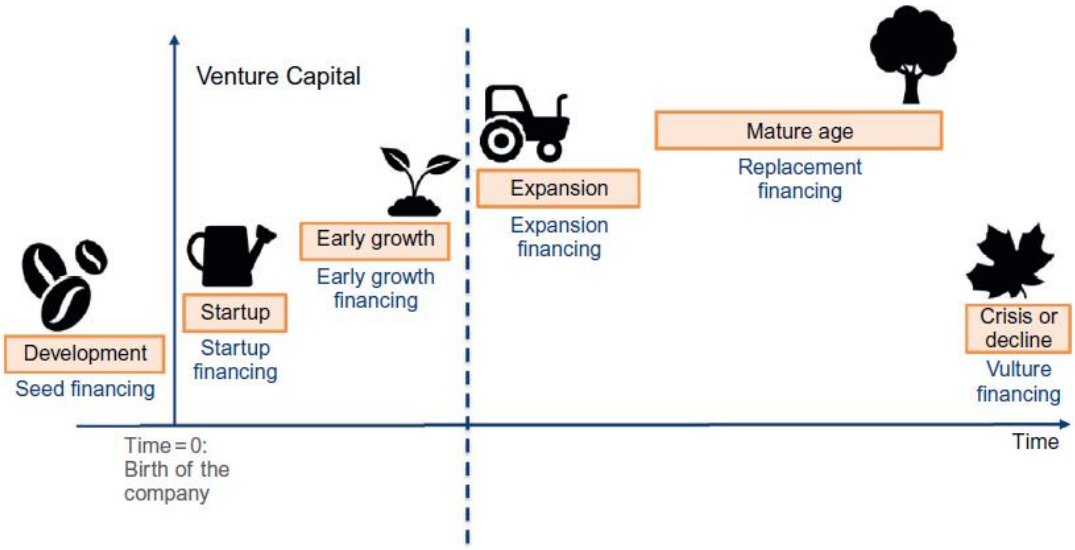
This paragraph summarizes the stages of growth of a firm and the relationship with the investment activity put in place by venture capitals and the other private equity operators. The latter should be carefully associated to the most appropriate stage of the firm's growth, because each of them has its own criticalities and risks.

Venture capitals do not have a dedicated stage in which they exclusively invest. Despite funding mostly in the early stage, it is not a common rule. The venture capitals fund managers on average tend to invest the first stages. Larger funds tend to apply a staged investment strategy. Negotiating in advance with the incumbent shareholders the funding process can be unpacked in many rounds, this way the investor can decide whether to buy additional equity in a portfolio company that is showing positive signs of growth. The staged funding strategy serves as a hedge against losses as well, this way fund managers can cut financing on portfolio companies performing below the expectations.

Stages of financing are among the discriminating variables, as it will be later introduced, used by venture capitalist to differentiate their portfolio. Therefore, a closer look to risks and benefits of each stage helps understanding the decision-making process during the investment phase.

Figure 2.3

The stages of private equity financing and firm's lifecycle



Source: Caselli Stefano, Negri Giulia - Private equity and venture capital in Europe - markets, techniques, and deals - Academic Press (2018)

2.3.1 Seed financing

The very first round of financing that firms may require is the so-called seed financing. It is the stage when the product or service has not been fully developed yet, thus, the firm is not ready to enter the market. In absence of revenues from sales the ongoing development needs to be fuelled by external inflows of money. The funding in this stage is aimed at turning R&D projects into concrete and marketable businesses.

The risks level associated to this stage is extremely high, mainly because of uncertainty in expectations. In these cases, there are several difficulties in making an evaluation of future performances. The first cause of uncertainty is related to the development, sometimes called technological uncertainty. It is hard to say ex-ante whether a development project will make it till the end of a series of tests and validating procedures. Feasibility studies can be previously conducted, even though nowadays there is an extensive use of simulation tools and scenario analysis, there is not a way to be completely sure about failure or success. This is a specific feature of pharmaceutical and biotechnology research, in which high complexity and costs at the beginning are accompanied by high uncertainty of successfully developing a marketable product.

Since the entrepreneur might not have any collateral assets to offer, debt-based financing might not be accessible. The financial help from private equity investors is bundled with little managerial help. In this phase the investors' expertise supports the business plan drafting and the team composition.

This phase is mostly targeted by business angels and business incubators, that, supplying the first round of equity financing, help the entrepreneur in building credibility to attract larger investors and move to the next stages of growth. Various authors in the scientific literature differentiate this stage as the informal private equity market from the later stages considered more institutional. Some of them identify also a previous stage of pre-seed where the only sources of financing are the "three Fs" family, friends and fools. In this view business angels can be seen as the link of the chain that bridges firms from informal to institutional private equity.

2.3.2 Start-up financing

After the formalization of the business activity as a legal entity the start-up financing comes in to play. The financing is, therefore, used for the establishment of the operational framework. To start the production process, at this point, the money is spent mostly to buy the production assets such as equipment, raw materials and plants. It is also called the series A financing. It usually represents the first injection of capital by venture capitals and the latter often receives equity shares in form of class A shares. These shares carry advanced benefits to the holder to whom is usually given priority in liquidation and dividend issuance, in exchange for renounce to voting rights.

The risk associated to the investment is lower. Usually in this phase the technological uncertainty has been overcome. An entrepreneurial idea that has made it to the start-up stage has proven technical feasibility, so a sustainable production process can be put together. The majority of the uncertainty is determined by two variables, the financial need and the time to breakeven, both highly exogenous to the entrepreneur ability and much more related to the market. Having not been tested yet, the level of market pentation and share is unknown, therefore, the future revenue streams can be only estimated on assumptions. Making such assumption might be a task that the institutional investors can manage. Their value added usually consists in business plan definition, market segment analysis and guiding the composition of the team. Coming up with a convincing business plan is a criticality and a priority to attract further investments in the next stages. Sometimes a mismanaged entrepreneurial potential needs advice to find the most suitable market positioning, in order to fully exploit an innovative product or service.

2.3.3 Early stage financing

By early stage financing it is considered the round of funding that brings start-ups to the beginning of the life cycle to a real company. It still is a phase characterised by high uncertainty, a dramatic growth in an initial phase might cause an unjustified hype effect and eventually result into a bubble. The financial resources in this stage are used to build a solid strategic and organizational framework.

For most of the entrepreneurs this is the stage when real financing is contributed. There is a sturdier foundation on which to build the infrastructure that will sustain the business in the long term. The transition from start-up to company involves setting up both the core and the secondary functions of the business. The entrepreneur needs to build a strong management team, back-office structures, relationships with suppliers and distribution channel. The technical uncertainties have been overcome so the criticalities to be addressed now have a more generic nature applicable to various industries. For the latter reason, this is the preferred stage of venture capitals. The managerial support that the investors provide in the early stage does not require deep and expert knowledge of the technical aspects but could simply be the support in strategic decisions, marketing and customer service advice.

2.3.4 Expansion financing

It is defined as expansion financing the type of funding that entrepreneurs need to achieve a desired growth target. This is the stage of fast growth of the company where it struggles to strengthen its competitive identity in the market by increasing sales, usually by satisfying more demand or shifting to new markets. To pursue such business enlargement target, the firm could either develop new solutions internally or acquire another company. In the first case the investor value added is precious especially in inefficiencies investigation and investments evaluation. Gerken (2014) suggests the application of the SWOT analysis tool. The entrepreneur should objectively appraise the strengths, weaknesses, opportunities and threats to define, possibly aligned with the investor’s advice, an expansion plan.

Whereas when looking for opportunities of growth outside the company perimeter, the venture capital's network is useful to find the ideal candidate. This phase does not require a deep experience in the industry, so for this reason many institutional investors besides venture capitals are able to strengthen the business and intensify growth. Large international players have proven to be extremely efficient in guiding mergers and acquisitions operations through their expertise and network.

The expansion financing stage is less risky than all the previous stages. The company has overcome technical and market uncertainties and can now rely on a customer basis and revenues streams. The latter, however, could not be sufficient to finance new projects aimed at enhancing the value proposition of the company while sustaining the cost structure. For this reason, even a more mature company might be in need of new rounds of funding.

2.3.5 Replacement financing

Growth will eventually stabilize, and the firm reaches a maturity level. A mature firm has a defined stream of revenues on which to rely and both production and market share reached a level of saturation. The criticalities of the entrepreneur are not related to expansion targets anymore but rather to strategic decision making and governance issues. In such cases the term replacement capital is referring to the substitution of minority shareholders no longer interested in pursuing the business activity.

The associated level of risk is much lower because the business model has proven its worth, so it is not the typical deal for venture capitals. For this reason, private equity investors operating at this stage tend to buy larger amounts of equity and to act as a consultant partner.

2.3.6 Vulture financing

Vulture financing is the peculiar cases of investments in declining companies. Financial resources and management support in this case can determine life or death of a company. The practices of vulture financing are unusual, and little has been studied about. The risk of the investments increases again to extremely high levels since there are no guarantees that the firm will survive, and some macroeconomic factors may be out of reach of intervention.

2.4 The venture capitals journey

Venture capitals were born in the second post-war period in the United States. The American Research and Development, founded in 1946 by Harvard Business School and MIT professors, is commonly recognised as the first venture capital firm. They were initially structured as closed end funds, whose shares were mainly held by individuals attracted by the high potential rewards, whereas Institutional investors showed limited enthusiasm in the new investing behaviour. The economic and industrial growth that followed the end of the war was a main determinant of the new style of investing. Setting up a fund dedicated to a specific industry

gave investors the opportunity to freely choose an investment line that better reflected their objectives.

With the *Small Business Investment Act* of 1958, the US Federal Government started encouraging the funds' growth through tax dispensations and direct aids on loans. In the same year the Draper, Gaither and Anderson was established. It was the first venture capital to be structured as a limited partnership, in order to allocate the company shares in a reduced number of wealthy investors, differently than closed end funds that spread their shares to many inappropriate investors usually. In the 1960s and 1970s more and more companies followed the limited partnership tide, and venture capitalism started to weave its path together with technologically innovative firms. Many companies appeared along Sand Hill Road to have easy access to the may semiconductor firms emerging in the famous Silicon Valley in California. Since then every start-up from Palo Alto to Menlo Park exploiting the breakthroughs of digital, medical or data technologies has been backed by a Sand Hill Road Venture Capital firm.

Between the 1970s and the 1980s activity in the industry increased considerably thanks to new sources of funding as well. In 1978 $424 million were invested, 32% of which came from individual investors and just 15% from pension funds (Gompers and Lerner, 2001). The latter came to raise even more thanks to the *prudent-man rule* released by the US Labour Department in that year, allowing the pension funds managers to invest in riskier assets. This measure proved to be effective in boosting the flow of capital into high-risk investments and shifting the source of capital to pension fund. As a matter of fact, in 1987 when the annual contribution peaked over $4 billion the share of pension funds represented more than half of it.

Roaring successes of companies such as Apple Inc., Genentech, Microsoft and Sun Microsystems attracted additional waves of fund raising. By the end of the decade more than 650 firms managed $31 billion invested in funds (Pollack, 1989), seeking the next breakthrough and the resulting earnings from successful exits. However, due to a hype effect and the entrance of new inexperienced venture capitalist overinvesting in mature markets. The returns of the industry declined in the second half of the 1980s. This effect was reflected in the first years of the 1990s when the amount of funds raised declined because of the decrease in confidence of investors towards the whole industry. Besides the first initial losses of the venture capital firms, the industry increased dramatically the level of competition and suffered the consequences of the 1887 stock market crisis.

The venture capitals and private equity market went through a second boom after the slight decline that ended in 1994. Table 1 shows number of funds and amount of capital managed. The unpacking in sources of funds highlights the impact of pension funds in boosting the fundraising, alongside with the intensification of expenditure by private corporations. Many firms started to look at the benefits of venture capitalism in fostering innovation and Research and Development (R&D) projects. Companies like Cisco Systems turned around the concept of innovation process management shifting internal R&D to venture capitals investments alternative.

Table 2.1

Summary Statistics for venture capital Fund-raising by Independent Venture Partnerships

	1979	*1983*	*1987*	*1991*	*1995*	*1999*[a]
First closing of funds						
Number of funds	27	147	112	34	84	204
Size (billions of 1999 $)	.53	6.01	5.93	1.69	4.60	37.46
Sources of funds						
Private pension funds	31%	26%	27%	25%	38%	9%
Public pension funds	[b]	5%	12%	17%	[b]	9%
Corporations	17%	12%	10%	4%	2%	16%
Individuals	23%	21%	12%	12%	17%	19%
Endowments	10%	8%	10%	24%	22%	15%
Insurance companies/banks	4%	12%	15%	6%	18%	11%
Foreign investors/other	15%	16%	14%	12%	3%	22%
Independent venture partnerships as a share of the total venture pool[c]		68%	78%	80%		

Source: Journal of Economic Perspectives-Volume 15, Number 2_Spring 2001

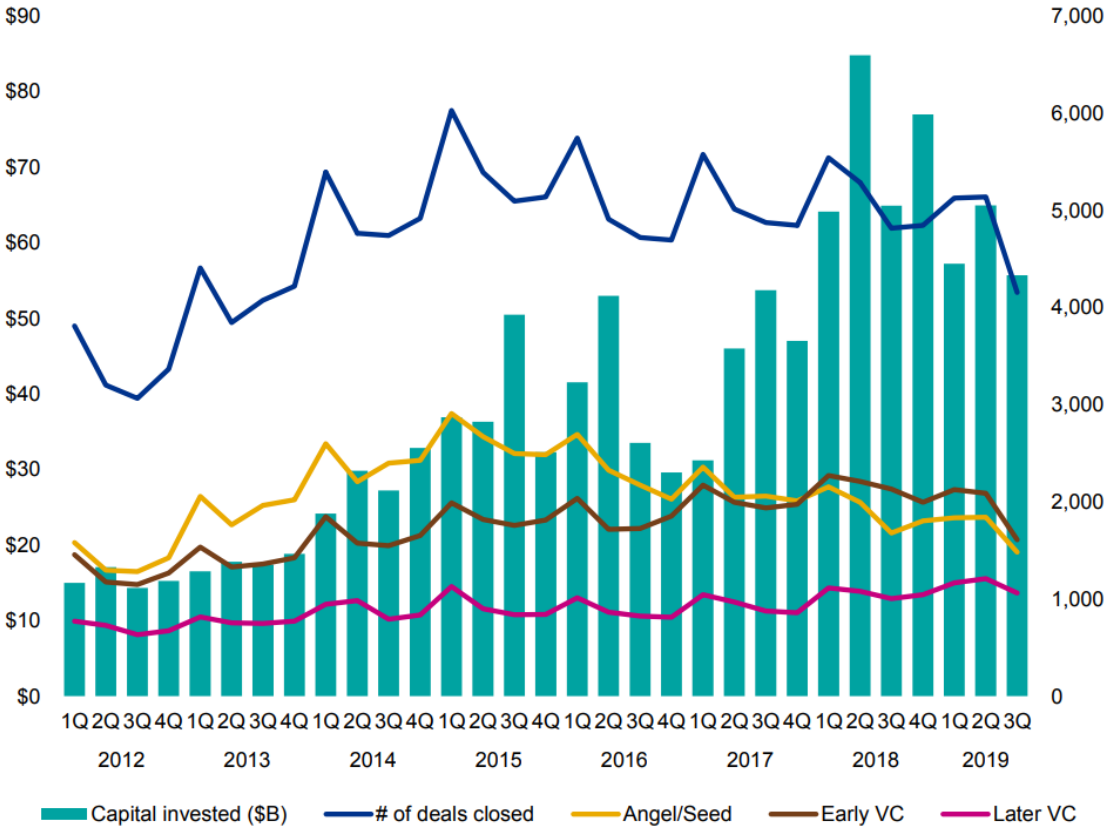
Given all this causes, the main trigger of investments in innovative firms during the 1990s was the rise of the internet or the so-called Dot-com bubble. Venture capitalists started internet focused investment strategies. For example, the venture capital firm Kleiner Perkins set up the Java Fund as a mechanism for a variety of corporations interested in stimulating demand for software written in the Java language to invest in companies with potential new applications (Gompers and Lerner, 2001).

Year 2000 eventually came, and the internet bubble crashed. Value of technological companies fell, and many funds were forced to divest several assets. By 2003 the whole industry had shrunk to half the size and venture capitalists' reputation was severely damaged.

Slowly and patiently the fund managers were able to rebuild the business around the next generation of market changers and eventually the industry experienced a second golden age. The 2010s were extremely positive years for both the funds and the portfolio companies, such as Facebook, whose memorable IPO in May 2012 remains between the greatest venture capital backed successes.

Figure 2.4

Global venture capital funding



Source: Venture Pulse, Q3'19. Global Analysis of Venture Funding, KPMG Enterprise. Data provided by PitchBook, October 9, 2019.

In the last decade, as showed in *figure 2.4*, the global industry kept an upwards trend stable with a peak of more than $80 billion of capital investments in the first half of 2018.

3. Investments decision making and diversification

This chapter is meant to understand that venture capitals do not have homogeneous market behaviour and business strategy. It will address the main theory concepts behind venture capitals investment decision making with a review of the most important scientific literature on the subject matter.

The chapter opens with an overview on the venture capital cycle, in other words, it will be described the path of the risk capital that is taken form third parties' investors, gets to finance the start-ups and eventually after the exit is payed back to the investors with a profit. The phases will be analysed under the venture capitalist's point of view and it will be addressed the main connections with diversification decision making during each one. The second paragraph takes a closer look to the classical diversification theories and explains why and how they can be applied in the venture capitals' context. It will be also introduced the two most popular ways to compute analytically the diversification index. The fourth paragraph addresses the diversification of venture capital investments under two opposite points of view: the financial portfolio perspective and the knowledge management and organizational learning perspective. Both points of view are applicable to the venture capitals' framework with contrasting pros and cons. It will be briefly introduced a set of potential diversification strategies that a venture capitalist may use across some variables on which he can act upon. The last paragraph focuses on the syndication, also known as co-investment, as a strategy used by venture capitalists to increase fund diversification.

3.1 Venture capitals cycle

The greatest deals of the most successful venture capital funds are not just a bet on the most promising horse. The business process behind the curtain is complex and time consuming. The venture capitalist has to go through a series of step in the value creation chain as illustrated in *figure 3.1*. Fund managers should raise enough capital to be endowed in the fund, select carefully the potential high growth investment opportunities, efficiently nurture the entrepreneurial firm and eventually liquidating making an exit that satisfies the investors' target in terms of internal rate of return (IRR).

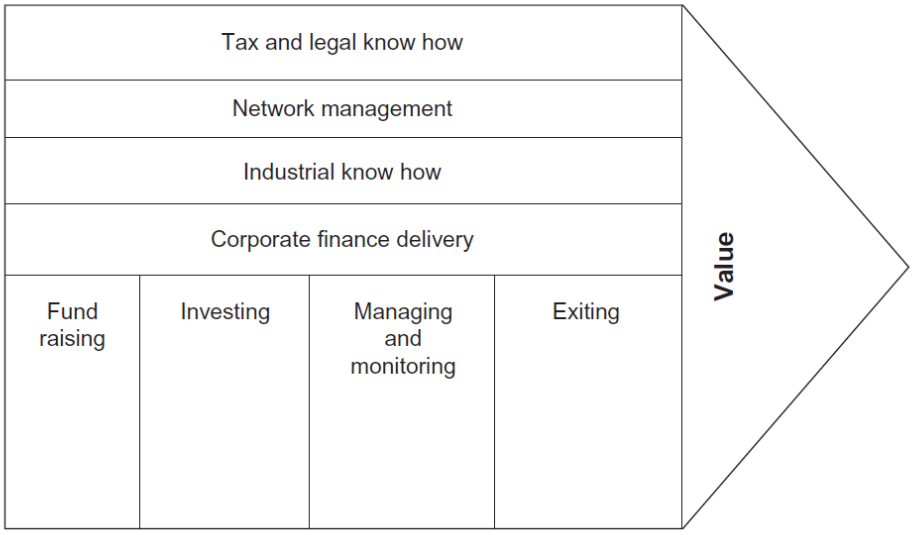
The end of the value creation chain delivers the benefits created to all the actors involved in it. Beneficiaries of venture capitals' activity can be either the portfolio companies who get their projects financed or the limited partners whose capital is invested and managed in sectors where they lack skills or the fund managers who receive compensation and accumulate experience.

The following paragraphs will explore in detail the four pillar of venture capital's value chain. It is the most generic framework of analysis since it does not depend on specific characteristic of investors and companies. In fact, the stages in which the cycle is subdivided are applicable to the other private equity financing alternatives, hereunder it will be only analysed under the

venture capitals' perspective and providing insights how diversification strategies affect each stage.

Figure 3.1

The value chain of venture capital firms



Source: Caselli Stefano, Negri Giulia - Private equity and venture capital in Europe - markets, techniques, and deals, Academic Press (2018)

3.1.1 Fundraising

The first task to be addressed by the venture capitalist is the fundraising. The objective is securing capital commitments from investors, that later will become the limited partners in the partnership agreement. It is the phase in which there is the meeting of the need of two parties. The fund managers look for money to create the fund and the investors seek for above the average return opportunities that cannot be satisfied with public market investing. It represents a delicate and laborious phase, even tougher for young funds with no history of deals to prove their reliability in the eyes of investors. As a matter of fact, investors are attracted more by those teams that boast the highest IRR in past exits.

Investors might limit fund managers strategies in several ways. Usually they make sure that no other fund is established while the current one has not reached the end date. They could also prohibit the general partners from financing portfolio companies of other fund or even influence the investment strategy. There is little of research about this matter, but it is proven that investors are concerned in which industry or life cycle stage their money is going to be invested in. During this phase the level of diversification that the fund managers will apply is not explicitly discussed but the diversification strategy, if applied by the managers, is inevitably influenced and restricted by such concerns. Investors might require a fund limited to a certain industry or country. Mainly because of information asymmetries between the parties, the limited partners have limited resources and means to oversee general partner's behaviour. They

use their bargaining power to address the latter's fund management towards a safe path to reach the target IRR. It is, therefore, a primary issue to be aware of potential benefits or losses of diversification in the venture capital portfolio. In addition, orientating the investment conditions towards the right path, also by diversification strategies, from the initial stage might give access to the exploitation of the full potential of the fund being more confident in not losing opportunities for better performance.

The compensation scheme is agreed ex ante and negotiated in the partnership agreement. It consists in a management fee and the carried interest. The management fee is the commission paid by the investors to the fund managers is a fixed amount that enables to perform the activity paying for overhead costs to help running the investment activities and providing an income to general partners. Typically, it consists in the 2% of the capital invested in the fund. The carried interest is computed on fund returns on investment after the exit and on average it is around 20%. It functions as a performance incentive to align interests of fund managers and investors towards the maximization of returns. Depending on the funds bargaining power the carried interest can also be higher, however it is extremely hard to convince investors to renounce on their share of profits. Only top-tier venture capitals can have a fair negotiation with them who usually hold the higher ground.

For such reasons, unexperienced or unpopular venture capitalists might be willing to turn down performance incentives to attract investors. The primary concern of a new venture capital fund is to establish a good reputational background to be able to raise larger amounts of funds in future ventures. Several researches (Gompers and Lerner, 1999) demonstrated this significant esteem concern that negatively affects both fund managers compensation and investment strategy during the negotiations.

3.1.2 Investing

Concluded the fundraising phase, the following phase of investing is aimed at allocating the financial resources previously collected. While the previous task involved a dialog and a negotiation with the potential investors that became limited partners, this phase consists in the scouting of entrepreneurial firms that at the end will become portfolio companies.

The investment phase starts by picking a set of candidates and evaluating the potential opportunities. Once the target companies have been identified the deal is finalized by contracting the size of shareholding and the perimeter of managerial involvement.

Venture capitals look for entrepreneurial companies that overcame technological uncertainty, so usually in the start-up and early stage financing. It is commonly believed that venture capitals look for passionate and ambitious entrepreneurs in the first place, however Bob Zider (1998) argues that they rather seek for investments in profitable industries. The companies in those stages still face market uncertainty, for this reason, venture capitalists are more concerned in betting on the right industry rather than finding the most competent management team. Since predicting future performance and overall industry profitability in the early stages is relatively difficult, the process that leads to the firms' selection should be long and accurate. This is true especially for those firms relying on many intangible assets or that have objectives hard to

valuate in monetary terms, such as research projects that quite often in the biotech environment are undertaken just for the sake of scientific recognition. The decision-making process is a complex and rigorous phase to support the subsequent deal making with the maximum level of confidence. It is a stepwise process in which rigid methodologies are often supported by a little of intuition derived from past experiences.

The process begins with the screening of the whole set of potential start-ups by considering the strategic orientation on the venture capitalist. The latter is a combination of desired features such as industry, type of product or service or technology, geographical location and stage of growth. As it will be explained in further detail in the following paragraphs these are parameters of differentiation that the investor requires implicitly or explicitly in the selection of the right firm to include in the portfolio. This is probably the most delicate phase in terms of differentiation strategic decision-making, because from this point forward the projects under analysis will belong to the same area, industry or stage. The screening process will discard half of the candidates on average, the remaining ones will be investigated in depth.

The firms that survived the screening process will have their detailed business plan carefully analysed under the perspective of a medium/long-term strategic plan. The investor should be able to make realistic assumptions over the revenues and costs structures performing a proper due diligence. During this phase the investor is able to assign a level of risk by assessing the potential deviation from the forecasted IRR. The main aspects considered in this phase are the market positioning, the financial sustainability and the tax and legal issues. For the purposes of the diversification strategy the market positioning due diligence should be carried out meticulously. The managers assess the typical forces, theorised by Michael Porter, that characterise an industry and determine risks and profitability such as level of competition, barriers to entry, substitute products and bargaining power of buyers and suppliers. It is a crucial moment to evaluate potential impacts on the portfolio of companies' overall risk, as replicating investments subject to the same risk factors increases the portfolio exposure due to the sum of similar idiosyncratic risks. Therefore, investors' decision making in the single project should not be considered in isolation with respect to the rest of the portfolio of investments (Buchner et al., 2017).

The few entrepreneurial companies that succeed in convincing the investors will receive a proposal of the price with which begins a negotiation phase. During this phase not only the amount of capital to be supplied is settled but also the delivering method and the governance rules. Given the high risk of investing in early staged companies the selection process is so severe that on average of 100 companies screened 10 will receive the investment and only 1 will pay back the expected profits. For this reason, the venture capitals' funds are filled with several high-risk but potentially high-growth portfolio companies, of which only a small percentage will be successful enough to cover the losses of the major part and eventually provide some profits.

Besides an accurate assessment of the business potential and the entrepreneur's skills, venture capitals make use of different tools to mitigate the information issues due to asymmetries between the actors involved. The set of tools consists in: distributing the investment in discrete

stages; syndicating with other venture capitals; taking seats on the board of directors and compensating with stock options (Gompers and Lerner, 2001).

By setting up a plan of staged capital infusion the fund managers are able to cut financing from projects underperforming with respect to expectations. Frictions and mismatching over management decisions are frequent and many venture capitalists take into account the possibility of reducing the funding with less regrets whenever they believe a mismanagement might lead to potential losses or the business idea is not so appealing as before.

By syndicating the venture capitalist brings another peer to invest together. There are multiple benefits associated to this practice, which is, indeed, used extensively by venture capitalists. Jointly investing allows to set up funds with a larger number of portfolio firms, thus, reducing firm-specific risk. Syndication as a diversification strategy will be analysed in detail in paragraph 3.5.

For the purposes of the third pillar of venture capitals cycle, which is the monitoring, the managers are added to the firm's board of directors. It is directly from the inside of the management of the company that the venture capitalist oversees the growth of the investments made and is able to provide advisory services. Sitting at the table along with the rest of the firm's management the venture capitalists can formally influence the strategic decision-making for the sake of the value growth. This is another way to align the parties' interest and to prevent the entrepreneur from making an opportunistically use of the capital received. Further influence can be exercised on the firm's managers by distributing equity shares and option as compensation means.

3.1.3 Monitoring

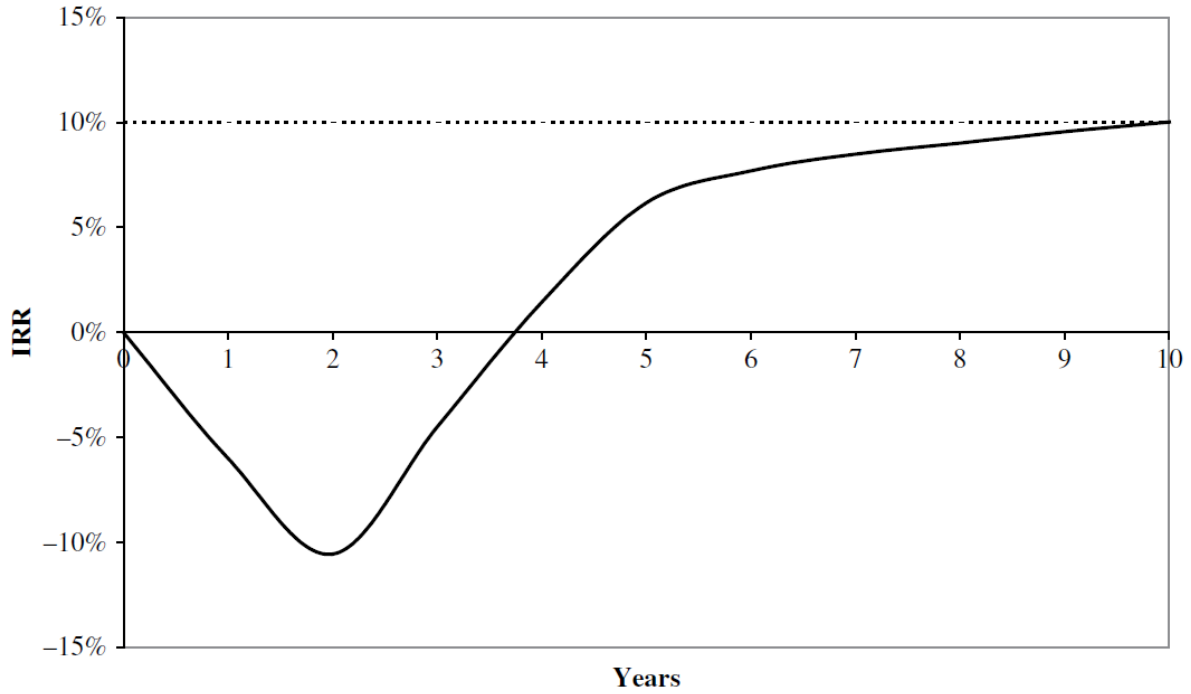
Once the deal is formalised the venture capitalist and the entrepreneur undertake a path of collaboration in order to raise together the value of the project in which both believe. The true commitment of both parties, towards the common goal of which will eventually provide mutual benefits, is the key for the successful exit. Just like marriages there are ups and downs, contrasting opinions and points of view which is primary concern to regulate before starting to work together. As aforementioned the investor will become an owner of the firm with the acquisition of the equity stake, which entails also the acquisition of direct management rights. There is not a universal solution for the agency problems during the monitoring phase, therefore, successful management depends heavily on how meticulously has been regulated the collaboration in the contracting phase. Frictions and opportunistic behaviour are frequent and unavoidable in most of the cases, but this should not discourage both the parties because it is an underlying factor of the business framework. Venture capitalists have their own objectives and constraints in terms of profitability, given also the portfolio view of the single venture as a piece of diversified fund, and responsibilities towards the limited partners. Whereas the entrepreneurs might have personal interests regardless of the financial success.

In order to start addressing the monitoring activities and their impact on the portfolio company performance it has to be defined an objective criterion to measure such improvements. As many venture capitals do, and as suggested by Invest Europe, the best way to evaluate the

investment's performance is through the IRR calculation. The evolution of the IRR indicator for private equity deals is different from the publicly traded equity deals, it has the typical shape of the J-curve as showed it *figure 3.2*. The initial phase is characterised by poor performance and negative cash flows because the firm spends the financial resources committed by the investor to put in practice the business plan. The returns' decline will eventually reach the lowest point, called the "death-valley", which represents the turning point if the management of the firm proves to be efficient and competent. After 2 or 3 years on average the investment will gradually start showing an upward trend on the basis of positive returns that the value creation process is able to foster. After about 4 or 5 years the IRR will start performing on above zero values. The role of the venture capitalist is, therefore, to make sure that his managerial support is valuable in the moment in which the business is expected to reverse its course. Its duty is to create value and protect it from opportunistic behaviour, in order to exploit the IRR rally as soon as possible. In fact, the timing concern is not a secondary aspect to be considered during the managing and monitoring phase, as venture capitals set a lifetime of the fund of about 10 years. Therefore, the positive results, in terms of reaching the desired level of rate of return, are expected to be seen at the end of the 7th year, otherwise the project might as well be considered a loss.

Figure 3.2.

The J-curve of private equity investments



Source: Pierre-Yves Mathonet, Thomas Meyer - J-Curve Exposure_ Managing a Portfolio of Venture Capital and Private Equity Funds (The Wiley Finance Series) (2008)

Investors that decide to adopt a hands-on approach in managing the portfolio company undertake serious commitment in the task being included directly in governance and financial decisions. The set of tools at the disposal to the venture capitalist to create value are several business supporting activities, that have been summarised on the horizontal upper sections of the value chain in *figure 3.1* such as: industry know how to increase operations efficiency; tax and legal advices that a company might require moving towards a larger scale; access to the established network of trusted professionals to find clients, suppliers and potential external strategic partners; financial advice which is, the most of the times, the main skill of venture capitalists.

In order to protect the value created there are various practices that can be applied during the monitoring stage, many of which come from traditional project management. It is common practice to set up plans and milestones to keep the performance in line with the growth strategy. It is a way for the managers to keep a tight leash on the entrepreneur's behaviour. The parties can agree on periodic moments of review of the project progress status, and if required drawing up remediation plans to bring it back on track. Besides rules and objectives there is also an opposite view which is by motivating employees providing rewards on performance.

On the other hand, there are venture capitals' fund managers that choose to adopt a more hands-off approach, delegating the strategic management of the portfolio company. The degree of involvement in the financial and operational management depends highly in the time availability of the fund manager. As a matter of fact, in the investment phase it must be considered not only the amount of money to allocate on each venture but also the amount of time to be dedicated in nurturing the company. There is no strict relationship on the amount of time spent managing a company and its rate of return. Even devoting most of the effort in a single underperforming company, if the external conditions do not allow it, the recovering sometimes is not possible. However, many researches and intuition suggest that the more time a manager dedicates to the company the higher are the chances of success because of all the benefits of the value added described in this paragraph. Thinking in terms of diversification the theory suggests managing more investments at the same time to reduce the portfolio overall risk, however, a larger number of projects to manages reduces the amount of time that the manager can spend adding value, therefore, reducing the probabilities of success. On average a fund manager has a total of 2,000 hours of work per year and a portfolio of 10 companies. If the time spent acting as a consultant is 40% of the total then each company will be looked after for 2 hours per week (Zieder, 1998). There still is no objective answer whether this could be the optimal time allocation with respect to the number of portfolio companies in the fund.

3.1.4 Exiting

The final step in the venture capitals cycle is the exiting. The equity stakes are sold to third parties eventually generating a profit and complying with the specific targets in terms of desired IRR and fund providers requirements. It is a delicate moment that is not determined ex ante due to the influence of many exogenous variables that determine it. The exit decision depends heavily on the timing and the mean but influences by the industry environment and overall market trend are relevant as well.

Private equity deals, besides the high risk, are characterised also by very low levels of liquidity and for such reason determining in advance such medium-long term investments is impossible. The timing of the exit often occurs between 5 and 7 years (Caselli and Negri, 2018) from investment inception.

The exit means are various. The equity stakes can be sold to third party investors, either individuals or larger companies, through private negotiation. Sometimes through buyback operations the existing shareholders want to increase their ownership rights in the company. On balance the best exiting strategy of all is considered to be through Initial Public Offering (IPO). Bringing the company public is considered in the private equity market an extraordinary success both in financial and reputational terms.

3.2 The theory of diversification

The previous chapter described the typical process by which venture capitals are able to make profits through their value chain. It has contextually been introduced the relationship between investments strategy derived from diversification along the steps that bring the capital raised from the external investors through the monitoring of the portfolio companies to the final exit of the deal. The diversification of investments intended as a strategy of mixed capital allocation is not a peculiarity of venture capitals, it is rather a general theory of financial studies that only recently has been explored with greater concern in the private equity environment.

The theoretical comprehension of the diversification dates back to the modern portfolio theory advanced by Harry Markowitz in the 1950s. In his "Portfolio Selection" (1952) the assumptions state that investors have the power to structure a portfolio of assets that maximizes the total returns for a given level of risk. The main idea is that owning a set of financial assets different between themselves is less risky than holding a position in only one. The theory was born considering that investors are risk adverse and when considering the purchasing of a financial asset the risk-return assessment should be done not just on the single asset but rather in the effect on the overall portfolio risk-return profile. The theory uses as risk measure the variance, which the squared standard deviation, or rather the dispersion from the mean.

The mathematical model implicates that a portfolio is composed by assets which have an individual expected return R_i (i discriminates between the various assets) in which fractions of wealth x_i have been allocated. Therefore, the expected return of the overall portfolio R_p, is given by the weighted sum.

$$\mathbb{E}[R_P] = \sum_{i=1}^{n} x_i \mathbb{E}[R_i]$$

The total variance of the portfolio return σ_P^2 by the general properties of the variance is:

$$\underbrace{\mathrm{Var}(R_P)}_{\equiv\sigma_P^2} = \mathbb{E}[R_P - \mathbb{E}[R_P]]^2$$

Substituting the weighted sum in the variance expression:

$$\sigma_P^2 = \mathbb{E}\left[\sum_{i=1}^{n} x_i R_i - \sum_{i=1}^{n} x_i \mathbb{E}[R_i]\right]^2$$

$$\sigma_P^2 = \mathbb{E}\left[\sum_{i=1}^{n} x_i (R_i - \mathbb{E}[R_i])\right]^2$$

$$\sigma_P^2 = \mathbb{E}\left[\sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j (R_i - \mathbb{E}[R_i])(R_j - \mathbb{E}[R_j])\right]$$

$$\sigma_P^2 = \mathbb{E}\left[\sum_{i=1}^{n} x_i^2 (R_i - \mathbb{E}[R_i])^2 + \sum_{i=1}^{n} \sum_{j=1, i\neq j}^{n} x_i x_j (R_i - \mathbb{E}[R_i])(R_j - \mathbb{E}[R_j])\right]$$

$$\sigma_P^2 = \sum_{i=1}^{n} x_i^2 \underbrace{\mathbb{E}[R_i - \mathbb{E}[R_i]]^2}_{\equiv\sigma_i^2} + \sum_{i=1}^{n} \sum_{j=1, i\neq j}^{n} x_i x_j \underbrace{\mathbb{E}\left[(R_i - \mathbb{E}[R_i])(R_j - \mathbb{E}[R_j])\right]}_{\equiv\sigma_{ij}}$$

$$\sigma_P^2 = \sum_{i=1}^{n} x_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1, i\neq j}^{n} x_i x_j \sigma_{ij}$$

Where σ_i^2 indicates the variance of asset *i* and σ_{ij}^2 the covariance between assets *i* and *j*. The covariance extended formula is:

$$\sigma_{ij} = \sigma_i \sigma_j \rho_{ij}$$

Where ρ_{ij} is the correlation coefficient of the returns of assets *i* and *j*. Assets moving in the same direction and by the same extent are said to be perfectly positive correlate, whereas assets moving in opposite direction by the same extent are said to be perfectly negative correlated. Typically, investors look for assets with the lowest degree of correlation, which means with a ρ_{ij} as closest to zero as possible. By selecting pairs of assets perfectly uncorrelated, which means that the coefficient has null value, the portfolio variance is the weighted sum of the assets' variances. This implies that an investor may build a portfolio which reduces the overall risk level, by simply combining uncorrelated assets.

Markowitz theories opened a whole new understanding of the portfolio composition, which gave an impulse in further studies aimed at acquiring deeper knowledge of relationships between assets. In fact, during the 1960s, mainly due to William F. Sharpe work, it was

developed the Capital asset pricing model (CAPM), which still in our days represents the most popular model for building a diversified portfolio. The CAPM evaluates the fair value of a financial asset based on the time value of money and the asset's sensitivity to systematic risk. The latter, also called market risk, is the measure of the impacts coming from overall market fluctuations shared by all the assets. The model uses the expected return and the systematic risk to price the securities with respect to the market, therefore linking the desired returns to the market exposition. The main assumption on which the model stands is that the optimal portfolio composition follows only the influence of systematic risk. It is therefore possible to sketch the so-called efficient frontier in the risk return graph, which offers the maximum level of expected return for each level of risk that can be reached through diversification. In this framework diversification is the way to eliminate the other component of variability in the unsystematic risk. Also known as specific risk this other kind is strictly related to the individual asset and theory says that can be diversified away by adding further uncorrelated assets in the same portfolio. Given this understanding of systematic and unsystematic risks strategic asset wealth allocation on a single asset takes into consideration not its own characteristics anymore but rather to its contribution to the overall portfolio. The well-diversified portfolio is protected against downturns in a single industry or region, but still exposed to the risk of the market as whole which cannot be diversified away.

There is no determined optimal number of assets that dictates a good diversification from a bad one since the mutual relationships are carefully evaluated. Simultaneously there is no upper limit to diversification as long as there is funds and assets availability. Some fund managers use a risk parity approach in the capital allocation when considering portfolio diversification. The share of wealth allocated to each asset is inversely proportional to the relative level of risk, building this way a risk balanced portfolio across asset classes.

Besides its popularity there is no shortage of criticisms to modern portfolio theory and Capital asset pricing model. Mainly because of the reliance of the models on expected values, that if estimated on historical data might fail to give a solid representation of future events.

3.3 Diversification Measure

Measuring the degree of differentiation of a portfolio is a primary concern of this analysis, however most of the literature lacks in defining a unique and formal way of calculation. The most intuitive measure is simply counting the number of assets in the portfolio. However, this measure fails to consider the fractions of wealth allocated, being the equally weighted portfolio just an extreme case, rarely adopted in practice. Another method suggested by Sharpe and Alexander (1990) consists in measuring the diversification by assessing the correlation coefficient of the expected returns. This method implies the availability of data from several time periods and continuous update based on changes in portfolio composition.

Some researches on the subject matter (Woerheide and Persson, 1993; Buchner et al., 2017; Cressy et al., 2012) use the complement of the Herfindahl–Hirschman Index. The latter is the most popular index to compute the concentration of a market and the level of competition amongst firms. It is computed as the sum of the squared market shares (W_i^2), which are the

ratios between each firm's sales and the whole size of the market, ranging therefore from 0 to 1, where 1 is the case of monopolistic market. The same concept can be applied to measure a portfolio differentiation considering not only the number of securities contained but also the amount of wealth allocated to each one, which is unbalanced in most of the cases. Assimilating a portfolio or in the case of private equity firms an investments fund to a market it can be computed a diversification index as follows.

$$DI(1) = 1 - HI = 1 - \sum_{i=1}^{N} W_i^2$$

For stylistic reasons it is computed as the complement to 1, therefore, the diversification index (DI) assumes the value of 0 for an undiversified portfolio and the value of 1 for the maximum level of diversification. It is not recognised as a standard, but several literature strategic researches use it as a reference to quantify the level of diversification in order to make analysis and comparisons (Cressy et al.,2012; Buchner et al., 2017).

Less frequently used in literature but not less relevant there is the entropy diversification index (Palepu, 1985). The entropy measure relies upon three distinguishing aspects of a set of firms: the number of segments in which the firms operate, the distribution of sales among the segments and lastly the degree of relatedness among the segments. The third aspect is the peculiarity of the entropy measure. While the other indexes focus just on how the investments are split up amongst industries the entropy measure takes into account the possible synergies and overlapping operations between segments. Thanks to this, some restrictions of the other indexes are overcome as it can be divided in two components an unrelated one and a related one. The first one measures the diversification across operationally distant groups and the second one measures the degree of diversification within adjacent industry clusters. The aggregation of the two components gives the total diversification index as follows.

$$DT = \sum_{i=1}^{N} P_i \ln\left(\frac{1}{P_i}\right)$$

The formula is a weighted sum, for the N segments, of the share P_i in the *i*-th segment weighted by the logarithm of the inverse. Where, the segments (N) are portions of industry groups (*M*), which are larger clusters made of one or more segments ($N \geq M$). Within each industry j (j=1, …, M) is possible to compute the single related diversification measure using P_i^j as the share related to the total of industry *j*.

$$DR_j = \sum_{i \in j} P_i^j \ln\left(\frac{1}{P_i^j}\right)$$

Where

$$P_i^j = P_i \,/\, P^j$$

and

$$P^j = \sum_{i \in j} P_i^j$$

The overall related diversification is therefore

$$DR = \sum_{j=1}^{M} DR_j P^j$$

, which basically is the weighted sum of each industry diversification weighted by its share.

The unrelated diversification whereas is the weighted sum across the industries of the shares of each one of them as follows.

$$DU = \sum_{j=1}^{M} P^j \ln\left(\frac{1}{P^j}\right)$$

It can be demonstrated that the sum of the related component *DR* and the unrelated component *DU* equals the aggregated diversification formula as shown in the first equation of *DT*.

In order to assign a firm to an industry sector or another reference can be made to several taxonomies by national and international organizations. The International Standard Industrial Classification of All Economic Activities (ISIC) defined and maintained up to date by the United Nations Statistics Division classifies economic activities with a 4 digits code. The European Union has established the Statistical Classification of Economic Activities in the European Community (NACE) with a 6 digits code that has some correspondences with the ISIC.

3.4 Diversification in venture capital investments

Venture capitals' business is a complex role framed in a dynamic industry in which the key players adopt a wide spectrum of investment and management techniques. Just like modern portfolio theory states, venture capitalists are risk adverse investors, meaning that between two equal expected returns they prefer the less risky. On the contrary a riskier investment needs to compensate by higher perspectives of returns. This explains why much effort is put in screening the start-up candidates. When preparing to commit capital in an early stage company they want to be sure that the expected return is in line with the risk associated. Under this perspective the venture capitalist is an investor willing to accept high risks, consequently high potential losses, seeking for extraordinary returns. However, the financial theories of the CAPM are based on a few assumptions on homogeneous information and absence of fixed costs that may not be true in the venture capitals' business (Merton, 1987). Mainly due to the presence of fixed costs, complete portfolio diversification is not achievable.

Venture capitals have many different approaches to industries and investments so that there is no unique definition whether there is a common perception of diversification. As mentioned in the introductory paragraphs there are generalists and focused approaches. Some venture capitals tend to specialise their investments in specific industries, technologies, geographical regions or

stages of development. On the contrary the generalist approach is more prone to diversify the fund composition across the above-mentioned variables.

It is true that venture capitals are viewed most of the times as key financial players in the innovation economy, but at the same time knowledge management and strategy and organizational literature suggest an alternative perspective. Venture capitalist, as a matter of fact, are double-sided investors and managers of the companies in which they become shareholders. For this reason, the business can be studied with a double perspective: the traditional financial portfolio theories and the strategic market analysis. The point of view which prevails in the investor's mind highly depends on whether the risk-return ratio is seen alterable or unalterable. In the first case the portfolio companies in the fund are perceived as many other passive portfolio securities, for which apply the modern theories on portfolio optimization and risk minimization. On the other hand, if an investor feels confident in effectively modifying the course of events with his hand-on approach, then he might as well be seen as an active entrepreneur himself.

Under the financial portfolio point of view the venture capitalist is viewed as a portfolio manager whose objective is the maximization of returns for a given level of risk. Therefore, all the theories mentioned in paragraph 3.2 could be applied in order to allocate optimally the wealth over the potential investment opportunities, considering the benefits of diversification on overall portfolio exposure. Besides previous experiences and fund's history of exits, venture capitals can attract investors showing a robust portfolio strategy. Potential limited partners might require a detailed risk analysis on the impacts of a given strategy on the risk-reward trade off and expectations. As hinted in the beginning of the chapter, during the fundraising phase the diversification strategy and therefore the scope and boundaries of a fund are often agreed ex-ante. For example, deciding whether to buy many stakes in companies operating in different industries or to focus the fund's scope in just one, restricting the reach to a certain region or considering international opportunities. These are choices of investment strategies that vary returns size and riskiness. For such reasons limited partners are used to address and regulate these matters in advance.

On the other side, since between the major part of the industry players is much common to observe a hands-on approach therefore the body of literature on knowledge management and organizational learning suggests a different point of view (Barnett et al., 1994, Ingram and Baum, 1997). Venture capitals can leverage on cumulative industry knowledge acquired through past experience. Acquiring a good level of specific knowledge takes a long time and effort, therefore it is like incurring a cost. The cost of experience pays back with two benefits that eventually enhance competitive advantage. First of all, the venture capitalist will perform a more efficient screening of the potential ventures prior to the investment. Secondly it will be easier to solve problems and provide counsel to increase value in the phases following the investment. Moreover, the venture capitalist will establish a strong network of relationships within an industry. The latter is probably the most important benefit as it provides an advantage in both phases (Bartkus and Kabir, 2009): during the selection of the investment it will provide a larger pool of affordable opportunities; during the monitoring phase it will be of great help to find external solutions to address challenges never experienced. The sharing of specific knowledge is also believed to be faster and easier within the same specific domain than across

different domains (Matusik and Fitza, 2012). Strategical literature does not support only the benefits of specialization, the knowledge management field for example provides interesting argumentations about the diversification of the knowledge base. The possession of a diversified knowledge background, coming from heterogeneous experiences, enriches the fund manager with analogical thinking and the ability to identify hybrid solutions to innovative challenges reconnecting to similar challenges in different contexts. Similarly, to this context it could be viewed as a business strategy topic as well. Makes sense for a large corporation to expand into areas that might share the production resources or competences. It is the case of Uber, the ride-hailing company, that decided to launch the food delivery service Uber Eats. The expansion in a different sector was largely eased by the similarities between the logistics management software which did not require lots of reengineering to adapt the transportation of people to the transportation of meals.

Both views seem to push in different directions one towards a more specialised approach the other towards a generalist one. However, the two points of view do not exclude one another. A specialised fund manager that invested in early stage ventures might retain its shares while the firm grows towards maturity and simultaneously move towards a more passive approach (Bartkus and Kabir, 2009).

A double perspective can also be viewed found within the diversification strategies. Independently form high or low level of diversification, as anticipated in paragraph 3.3, the nature of diversification can be related or unrelated.

Related diversification is aimed at exploiting synergies and similarities between the ventures. To benefit from these synergies, venture capitals make sure that the diffusion of knowledge is efficient in the entrepreneurial business context. Managing related portfolio companies helps the reduction of coordination costs (Zhang, 2014). It makes sense because of the hands-on approach and it proves to be much valuable especially for early stage firms that face problems in building a feasible business model, recruit human resources, find additional sources of capital (Clercq et al., 2006). Getting back to the knowledge management perspective, it is a key aspect to point out that both successful ventures and mistakes in failed projects increase the knowledge base by learning effects (Clercq and Sapienza, 2005). Intuitively the effects are even more valuable when built over the same knowledge ground of similar experiences with the other related portfolio companies. Form the risk reduction point of view related diversification is not optimal for industry specific risk reduction, but thanks to the knowledge acquired in related ventures and the tools at its disposal the venture capital might be eventually able to discard riskier ventures earlier.

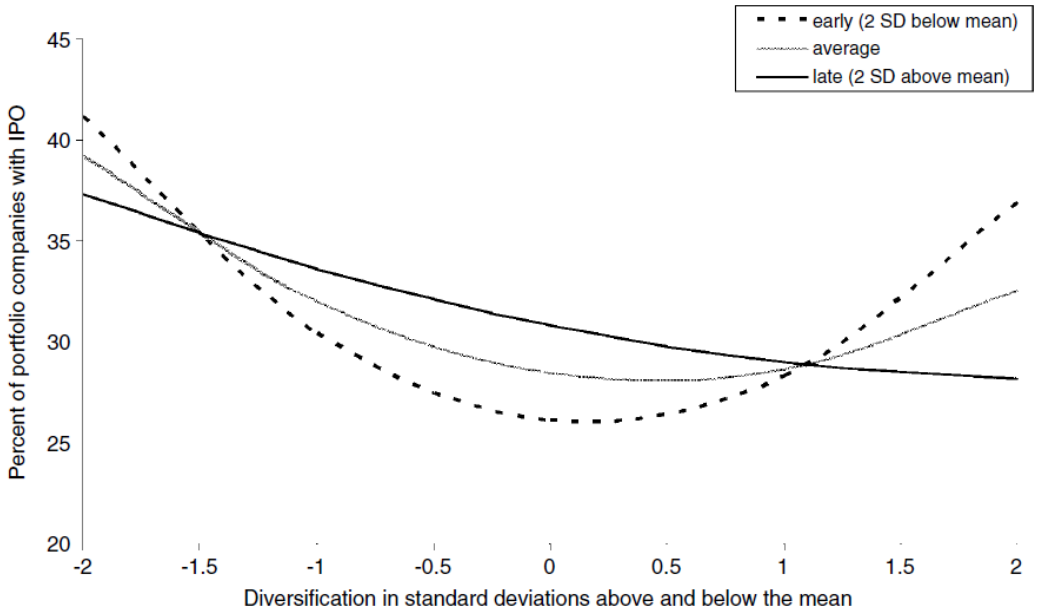
Unrelated diversification is considered to be more efficient where synergies between firms are not important, but mainly when they are primarily responsible for their own growth. Portfolio companies that share the same venture investor do not really share the same resources as it is more predominant the contribution in terms of capabilities and advice. Therefore, the need to find synergies between firms is limited, consequently supporting a diversification that provides minor involvement. This conclusion fits better with the general comprehension of portfolio management. Makes sense from the optimal portfolio point of view because it reduces unsystematic risk. Industries like biotech and computer software do not share many

determinants of profitability, whereas software and hardware industries are not an optimal mix to reduce such share of risk (Zhang, 2014). Diversified knowledge across unrelated fields, similarly to the knowledge management perspective, is useful to steer underperforming projects towards applications in different industries. A venture capitalist highly specialised in a specific industry might not be able to see beyond the limits of his field, therefore being unable to suggest opportunities in different industries or unable to provide aid when a portfolio company switches its applications to another industry (Matusik and Fitza, 2012). However, an unrelated diversified portfolio generally is made of many firms such that he management and monitoring of all the relative issues and challenges is more complex and fund managers have less time to dedicate to each firm.

Previous studies in the venture capitals diversification have showed contrasting results about its benefits on success rates (Buchner et al., 2017; Cressy and Malipiero 2012; Matusik and Fitza, 2012). Nonetheless it is interesting to consider the results of the work of Matusik and Fitza (2012). It has been assessed the relationship between level of diversification and fund performance. Their measure of diversification is based on the entropy index and because of unavailability of data about the IRR the performance of the funds is measured through the percentage of portfolio companies that eventually went through an IPO. The singularity of their work is that they saw a nonlinear relationship between the two variables, specifically a quadratic relationship. The hypothesis of nonlinear relationship generates from considering the pros and cons of specialisation and diversification abovementioned. At low levels of diversification effects of low coordination costs and specific knowledge prevail while after a certain level diversification effects will positively increase performance thanks to adaptability and flexibility. With the analysis pf a data set of US venture capitals' funds the nonlinearity of the relationship is demonstrated and in particular with a u-shaped curve, displayed in *figure 3.3*, that demonstrated benefits of both low and high level of diversification along with the negative effects on performance of medium levels. Using the levels of stage development as moderating variables, it was found that high levels of diversification provide great returns for the early stage firms. The u-shape hypothesis is confirmed, and the benefits are evident also for low levels of diversification. Whereas moving to later stages the curve gets flatter, demonstrating that diversification is less meaningful when investing in more mature companies.

Figure 3.3

Relationship between diversification and returns across development stages



Source: Sharon F. Matusik and Markus A. Fitza, Diversification in The Venture Capital Industry: Leveraging Knowledge Under Uncertainty, Strategic Management Journal 33: 407–426

In the following paragraphs it will be explored the main diversification variables used by venture capitals and investigated in scientific literature.

3.4.1 Industry diversification

Venture capital firms, concerned with diversification, during portfolio construction aim at maximising returns by selecting independent investments that assure a dissimilarity of diversification measures. The first one concerns the choice of the industry, product or service on which to invest.

Some firms tend to invest exclusively in the same industry or product specialising their knowledge on a given area such as biotech or software. Other firms build their portfolios selecting investee firms across industries. The first is the typical choice of the so-called specialised venture capital firms, which, because of the experience achieved in interacting with companies in the same business area, only apprise projects on their field of knowledge. Industry specialization finds great use and benefits during the monitoring phase. The venture capitalist that had been building industry-specific knowledge may be able to find better solutions and provide more valuable advice, especially in the early stage firms where the technological uncertainty is more challenging (Gupta and Sapienza, 1992). However specialised venture capitals might lose opportunities outside their specialization domain and might build a fund excessively exposed to firm-specific risk.

On the other side firms that push towards a diversified approach, the generalist venture capitals, are more concerned with the risk reduction benefits. As mentioned in the previous paragraph

the strategy of diversifying across industries is mainly justified by the effects in unsystematic risk reduction. Besides the benefits dictated by the financial portfolio theories the industry diversification finds supporting theories also in the knowledge management perspective. As a matter of fact, diversification might help building experience in thinking outside specific industry borders which might be an impulse for fund managers to develop outside the box thinking. Michael Porter's studies demonstrated that there are a set of forces and situations that are analogous for every firm regardless of the relative industry, therefore the skills for developing successful exits in one industry might be applicable in others as well.

3.4.2 Stage diversification

The second main dimension on which the venture capitals tend to diversify is the stage of development of the portfolio companies. As already discussed, early stage firms are associated with a higher probability of unsuccess. Firms tend to have a higher mortality in the first four years (Gupta and Sapienza, 1992) because of unsolved problems in market demand, technology development and management. Whereas late stage firms require larger investments and offer lower growth rates given a lower risk of default. A diversified by stage fund will therefore contain a balanced amount of early stage and late stage firms.

The stage variable is highly connected to the other choices in terms of diversification. Many research studies on the subject matter show how there is a connection between the industry diversification and the development stage of the investee companies. In the case of early stage ventures the industry diversification effects have positive impact on performance. High diversification seems to be more efficient in driving the success of an investment but low diversification as well has positive impacts. Coherently with the u-shaped relationship (Matusik and Fitza, 2012). Whereas it has also been found that late stage industry diversification is more common than early stage (Cressy et al., 2012). The latter result is supported by the consideration that it might be more feasible to manage diverse companies once the early stage and the related technological uncertainty has been overcome.

Among the factors included in the unsystematic risk, venture capitals face great exposure to liquidity risk associated to the timing of exit from an investment (Norton and Tenenbaum, 1993). Usually it takes from 5 to 7 years to bring a company form start-up to public markets. Therefore, a portfolio made of firms at the same stage will be eventually liquidated during the same period and so at the same market conditions. Whereas a development stage diversified portfolio helps venture capitalist taking advantage of many windows of opportunities for a fair valuation of the investments (Bartkus and Kabir, 2009). This strategy blends well with the financial portfolio point of view, however managing a fund diversified across stages would entail high logical complexity and a need of extreme flexibility from the venture capitalist.

An efficient strategy to cut losses is the staging of the investment, as mentioned in paragraph 3.1.2. Instead of providing the financing capital to the entrepreneur in lump sum, venture capitals often distribute the cash instalments over time. Especially for the investments in early stages, setting up a staging investment plan is a good way to minimize information asymmetries and agency problems, which are obviously more intense in such cases (Lauterbach, et al., 2007).

The staging plan along with contractual options accurately defined during negotiation allow the venture capitalist to cut, rethink or even increase investments in the future.

3.4.3 Geographical diversification

The third main variable of diversification is related to the location of the portfolio company. There are venture capitals whose investments are restricted to the national market or in some cases a certain region, like the Silicon Valley investors. On the other hand, there are investors whose operations have a broader scope outside the country.

While for the other diversification variables the fund's size does not matter it might not be the case of geographical diversification. When the portfolio companies are located closer to the venture capital headquarter it is, for practical reasons, easier to manage and control. Besides the logistical complexity of managing farther companies the costs that such diversification entail might be superior to the benefits captured. Unsurprisingly the venture capitals specialised in early stage ventures prefer less geographical diversification, as it would be required a closer and tighter control to steer the development in the right direction (Gupta and Sapienza, 1992).

It has been empirically demonstrated that geographically specialised late stage funds perform better (Cressy et al., 2012). Geographical diversification has a positive impact on fund's performance, mainly thanks to global integration of financial markets and the possibility to manage remotely with the modern communication technologies (Cressy et al., 2012).

3.5 Syndication

It is highly common in venture investing to observe multiple investors involved in the same round of funding. There are not only deals where the investor acts for its own financial interest, it also happens that more entities reunite themselves in a syndicate. A syndicate or a co-investment is a strategic alliance between professionals or companies to jointly manage a larger deal for a limited period of time. In the syndication agreement the parties, besides sharing the amount of funds provided, contribute jointly with physical assets, experience management services and advice for the needs of the entrepreneurial firm. More importantly venture capitalists may decide to co-invest in order to leverage mutual specialised expertise. In a co-investment deal each venture capital develops its own specialised knowledge base in order to carry out efficiently investments' selection and management. During the screening of opportunities phase the investors syndicating share the due diligence costs but essentially, they share a second opinion on the potential ventures to finance (Gompers and Lerner, 2001). Not surprisingly the venture capitalist that brings in another investor in a deal most often is more interested in acquiring a specific set of expertise rather than the money. It has already been discussed how important and how costly is to develop technical knowledge, therefore syndication is an efficient and cheaper way to bring in capabilities in which the venture capital lacks experience. As a matter of fact, researchers agree that syndication is both a need to diversify away risks as well as the way to obtain and share knowledge (Lockett and Wright, 2001).

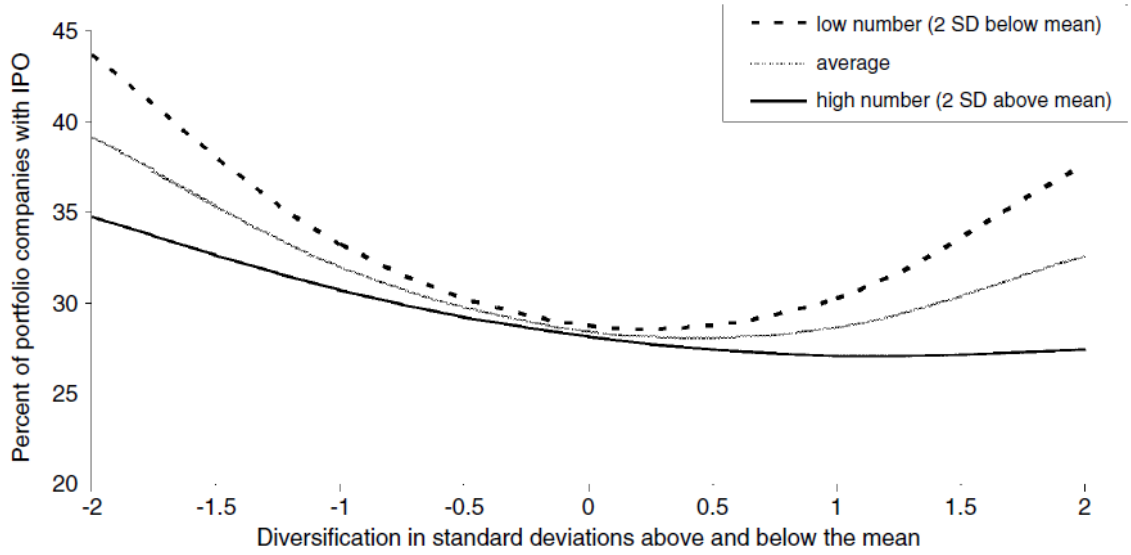
Syndication is not a specific feature of venture capital industry, it is rather an example of joint venture which is the general definition of co-investment. The distinctiveness of venture capital syndication lies on the reasons that push towards co-investment decisions. To summarise there are three main reasons for which venture capitals decide to co-invest rather than bearing the whole investment by themselves. First reason is to supply with more money the entrepreneurial firm. The venture capital firm might have reached a limit in terms of cash availability or it could have been set an upper limit of capital contribution into a single venture by the limited partners. In such cases if the management believes that further rounds of financing might be beneficial for the development of the entrepreneurial project the venture capitalist can bring in someone else from his trusted network who can secure the funds. Secondly, according to the financial portfolio point of view, the venture capital firm might want to share risk deal-by-deal that may lower the overall portfolio risk, along with the access to a larger pool of opportunities (Lockett and Wright, 2001). The third reason is linked to the availability of a broader set of deal flows which for a venture capitalist is of critical importance, especially if those deals come with a pre-screening so that effort and cost can be saved focusing on the race to obtain the best deal possible. It is of great strategic importance to be in the position of competing for the largest part of the deal when competition is fierce and availability of cash is high (Lockett and Wright, 2001).

Of the second reason there is evidence in the portfolio composition of the venture capitals involved in co-investment agreements. Syndication allows venture capitals to invest the same amount of capital in a larger number of firms, thus allocating a minor share of wealth in each venture. Moreover, the amount of syndication is connected to the uncertainty within the underlying industry. It has been found that co-investment and network effects are predominant in investments in the high-tech sector, mainly because of the knowledge sharing benefits and the elevated risk associated to such industry (Bygrave, 1987). These facts make venture capital investment and diversification strategies consistent with both the financial portfolio and the knowledge management views (Norton and Tenenbaum, 1993).

Co-investment is not immune to risks related to idiosyncratic factors related to such practices. Liquidity risk, for example, is generally higher for co-investment shareholdings, given a secondary market much more illiquid.

Matusik and Fitza (2012) performed the same investigation on the u-shaped relationship between diversification and performance with its interaction with the co-investment, as showed in *figure 3.4*. The results show that, in a similar way to the development stage, the lower the levels of co-investment the more significant are the effects of diversification.

Figure 3.4
Relationship between diversification and returns with respect to co-investment



Source: Sharon F. Matusik and Markus A. Fitza, Diversification in The Venture Capital Industry: Leveraging Knowledge Under Uncertainty, Strategic Management Journal 33: 407–426

The conclusions on the graph above suggest that co-investing ventures have a negative correlation with the diversification. However, the topic of co-investment by the authors has been intended just as a way to share knowledge and bring other rounds of funding not as a way to further increase and ease the diversification of a given fund. In other researches it has been demonstrated the positive consequences of syndication on both sides. It is, in fact, a win-win situation that is usually created when a syndicate decides to invest in a given firm. The investors can reduce portfolio risk and enjoy greater returns on investment, while start-up generally have higher chances of going public through an IPO (Checkley et al., 2010)

Form the point of view of the start-ups, the creation of a consortium of investor around them has generally positive impacts. The entrepreneur has access to a larger set of resources from various investors and is less subject to hold-up problems. In conclusion, while it is uncertain the effect of syndication strategies in venture capitals performance it is almost certainly an advantageous condition for the start-ups.

3.5.1 The lead investor

In a syndicate it can usually be found one or more investors acting as lead investor. It usually represents the investor with the largest stake in the venture and often the first to have committed capital. It can be viewed as a linking position between the firm and the other co-investors easing the communication and information spread through coordination and management activities with the firm.

More experienced venture capitalists might be able to sustain the whole investment on their own even financing the early staged firms in which it is required more active participation and care. Usually the other investors are brought in during the later stages, this way less experienced venture capitals can follow the lead investor when much of the uncertainty has been overcome and there is only a need of cash. Therefore, the propensity to syndication varies with the stage of growth and the amount of money required. Since the early stages require lower fundraising a single venture capital firm might be able to handle the whole investment, however the creation of a syndication after the engagement of a start-up precludes some of the benefits of co-investment. In fact, the lead investor would lose the advantage of sharing the costs and the knowledge during the investment selection phase (Lockett and Wright, 2001). The other investors look to the lead investor as a reference in dealing with the firm and put their faith on its judgement about due diligence and business plan. The statement above is generally applicable but not universally true since lead investors even in later stage might retain a little uncertainty about the success of a project and might be interested in an evaluation from another venture capitalist, not surprisingly the 70% of firms receiving funds from more than one investor witnessed the entrance of a second investor within one year form the original one (Brander et al., 2002).

4. Methodology

In order to make an assessment of the real-world situation of start-ups and venture capitals it has been conducted an empirical analysis on a sample of start-up funding operations organised in a database.

This chapter illustrates the sample selection procedure and it will be examined in depth the data manipulation techniques for the organization of the available data. Along with the definition of the entities, to be investigated, it will be showed the first set of descriptive statistics to perform a macro analysis of the market. The latter serves also to confirm the literature theories on start-up and venture capitals behaviour introduced in paragraph 3.1.

4.1 The sample

For the purposes of this thesis it has been selected a database of 1136 start-ups that has been created and maintained by the Department of Management and Production Engineering (DIGEP) of Politecnico di Torino. The database contains various fields of information about start-ups involved in projects of artificial intelligence (AI) technology development. All the firms contained received at least a round of financing, from external investors, belonging to the early stage series, therefore of interest for the scope of the analysis.

The data used to create the database has been sourced from the website www.crunchbase.com. Crunchbase is a web platform that collects information about companies and investors mainly belonging to the world of technology and innovation. It provides to users an intuitive view over the most important data about tech start-ups and emerging industries. The data presented to users is the result of contribution from a variety of sources: the internal development team; the venture program of partnering with firms; machine learning and the community. In fact, a great advantage of Crunchbase is the continuous update thanks to the information contribution from every user from a large community of professionals and researchers, that can send a proposal of information to be added. The information submitted is reviewed, checked, validated and later integrated to the existing volume of data. Besides the large amount of data and its accuracy, the platform allows the user to create lists and filters through which extract the most pertinent data required for the purpose of the analysis. It is also a powerful tool for entrepreneurs to gain popularity. Just like social media business accounts, it can help to raise online visibility of the firm through superior Search Engine Optimization (SEO). Most importantly it is a way to connect with venture capitalists and find investors, which have demonstrated to be actively involved in scouting activities through the platform to identify emerging start-ups.

The database has been built with information about start-ups coming from a large variety of countries which have been founded from 2005 to 2019, but all of them have in common the same field of interest which is the development of AI technologies. Those technologies are not meant to be addressed only in the computer software industry, in fact, the application of such

technology cover a wide variety of industries. that will be explained in greater detail in the next paragraphs which define the entities within the scope of this study, their attributes and their mutual relationships. The attributes are data that help to assess the industry object of analysis, in this thesis the AI start-ups and their investors. Some attributes have numerical values like the funding amount, some are text like the name of the firm, and some others are classified in categories like the sector of application. For each one of those attributes that assign categories to the entities it has been prepared a dedicated table listing the categories.

4.1.1 Start-up entity

The first entity to be defined is the start-up, which is the main collector of detailed information. Not surprisingly, the database has been built around the start-up entity and the information of the other entities has been dragged according to the relationships with start-up entities. The main attributes of the start-ups examined have been summarised in *table 4.1* below.

Table 4.1

Start-up entity attributes

Attribute	Description
ID Start-up	Identification number of the distinct start-up
Organization Name	Start-up name
Organization Name URL	Start-up website via Crunchbase
Categories	Keywords on the company's core business
Headquarters Location	Headquarters location
Nation	Headquarters nation
Description	Short description taken from Crunchbase
CB Rank (Company)	Crunchbase rank on companies to underline which arouses the greatest interest in real time
Headquarters Regions	Headquarters continent /region
Exit Date	Date of the exit
Exit Date Precision	Specifies that the exit date occurred in a period
Founded Date	Foundation date
Founded Date Precision	Specifies that the founded date occurred in a period
Website	Official website of the start-up
Facebook	Facebook page website
LinkedIn	LinkedIn page website
Number of Founders	Number of founders
Founders	Names of the founders
Number of Employees	Number of employees
Activity	Keyword indicating which type of AI is used
Sector	Indicated to which industry the start-up belongs
Application	Indicates the application purpose for which the activity is used
Human Capacity	indicates the relationship with man's abilities

The first attribute, ID start-up, is a sequential number assigned to each start-up as each one was entered in the database. It is the unique and distinct value that serves as a key to identify univocally the various singularities of the start-up entity. General registries of each firm have been collected such as the name, the location of the headquarters, addresses of websites and social media pages, date of foundation and rarely of exit, number and names of founders etc. More specifically to the type of business, the description attribute and the categories identify the core activities of the start-up, whereas the activity and sector frame the type of AI that is being developed and for which industry is meant to be applied. *Tables 4.2* and *4.3* provide an overview on all the possible categories of activity and sector that are represented by the firms in the sample.

Table 4.2

Categories of activity

Attribute	Categories
Activity	Voice Analysis
	Document Analysis
	Chat Analysis
	AI Training
	Augmented Analysis
	Web Vulnerability
	Mouse Tracking
	Eye-Tracking
	Image Analysis
	Facial Scan
	Predictive Machinery Maintenance
	Computer Vision
	Social Behaviour
	3D Reproduction
	Photo Editing
	Consulting
	Sensor Monitoring
	Drug Design

Table 4.3

Categories of sector

Attribute	Categories
Sector	Health
	Agriculture
	Marketing
	Mobility
	Advertising
	Advisory
	Security
	Retail
	Sport
	Financial
	Manufacturing
	Gaming
	HR
	Education
	IT
	Food
	Media
	Music
	Mobile Communication
	Customer Service
	Electronics
	Real estate
	Energy
	Infrastructure
	E-Commerce
	Assurance
	Logistic
	Travel
	Public administration
	Photo
	Gambling
	Service
	Aerospace
	Legal
	R&D
	Environment
	Robotic
	Entertainment
	Accounting
	Fashion

The activity attribute refers to the type of AI technology that is under development. There are several applications of AI, which despite the novelty of this researches, are used to perform a wide variety of activities. Activities performed by AI technologies might find useful applications across different industries. There is not a predefined one to one relationship between what activity AI can perform and in which industry, so all the combinations are possible. The database was built in order to give the possibility, where needed, of identifying up to two activities and sector so, for example, an AI technology for document analysis and augmented analytics is applied in health and financial industries. All these applications of AI are becoming more and more popular because of their ability of facilitating human effort in certain tasks. An AI technology that is meant to improve a person's ability is often said to be either increasing human's functionalities or replacing completely the human intervention, as showed by the categories of Human Capacity in *table 4.4*.

Table 4.4

Categories of Human Capacity

Attribute	Categories
Human Capacity	Increase
	Replace

Lastly it is important to define the attribute CB Rank (Company), which refers to the ranking score assign by an intelligent algorithm to the companies in Crunchbase platform. The ranking is a sequential number of positions on a chart, therefore, the lower the numbers the highest in the list is placed the company, with the number 1 company being the top of the list. The ranking in Crunch base is used as way to quickly identify the start-ups that are positively performing and to make comparisons. The algorithm takes into account several aspects like the funding, the connections with other entities, news articles and the number of recent views.

4.1.2 Investor entity

The entity investor gathers the individuals and the organizations that provided funds to at least one of the start-ups considered. The attributes that define the investors are summarised in *table 4.5*.

Table 4.5

Investor entity attributes

Attribute	Description
Name	Indicates the investors name
City	City headquarters of the investor
Nation	Nation headquarters of the investor
Investor Type	Type of investors
Founding Round 1	Indicates whether the investor participated in the first round of investments (yes / no)
Founding Round 1 Value	Indicates first investment round value
Founding Round 2	Indicates whether the investor participated in the second round of investments (yes / no)
Founding Round 2 Value	Indicates second investment round value
Founding Round 3	Indicates whether the investor participated in the third round of investments (yes / no)
Founding Round 3 Value	Indicates third investment round value
Other	Indicates investment rounds after the third

Similarly to the previous entity, generic attributes like the name or the location of headquarters helps distinguishing the individual investors one from the other. In addition, it has been gathered information about the founding activity of each investor with respect to each start-up. In fact, there is a one to many relationship in both directions for investors and start-ups. An investor could have invested in many start-ups, while a start-up could have been founded by more than one investor. About the investment operations there is a detail about which founding round has the investor taken part and the relative amount contributed.

The database contains different subsets of investors not exclusively venture capitals. The overview on the categories of Investor Type are showed in table 4.6.

Table 4.6

Investor type categories

Attribute	Categories
Investor Type	Venture Capitalist
	Family Investment Office
	Government Office
	Private equity firm
	Investment bank
	European found
	Accelerators
	Business Angel

4.1.3 Deal entity

The third entity defined is the deals entity. It represents a fundraising operation and is meant to be intended as the connection between the other two entities. The deal is an investment operation from one or more investors in a single start-up. Therefore, each start-up is associated to one deal, while each investor is associated to at least one deal. The last statement highlights the fact that, as explained in paragraph 3.5, the investors that choose to syndicate an investment are highly frequent.

The attributes of the deal are representative of the transaction's details and have at least one element of connection with the start-up and investor entities. Table 4.7 showed below lists all the attributes of the deals under consideration.

Table 4.7

Deal entity attributes

Attribute	Description
Number of Funding Rounds	Investment cycle number
Funding Status	Type of investment
Total Funding Amount	Total investment value
Total Funding Amount Currency	Currency of the total investment
Total Funding Amount Currency (in USD)	Total investment value expressed in US dollars
Top 5 Investors	The top five investors
Number of Lead Investors	Number of main investors
Number of Investors	Number of investors

The deal can be made of many rounds of investment, it has a total value which is converted in US dollars for the sake of coherence in comparison analysis. Each deal is associated to a start-

up and it is linked to the investors with the last three attributes, which also specify whether there is one or more lead investor.

In table 4.8 it is contained the list of categories of Funding Status, which defined the development stage during which the investment occurred.

Table 4.8

Funding Status categories

Attribute	Categories
Funding Status	EARLY STAGE
	IPO
	LATE STAGE VENTURE
	M&A
	PRIVATE EQUITY
	SEED

4.2 Descriptive statistics

Here it is depicted a macro analysis of the industry environment, by showing a few statistics of interest. The descriptive statistics of each entity are here below presented in the same order of the previous paragraph.

4.2.1 Start-ups

The firms contained in the sample are recently founded start-ups that are currently developing artificial intelligence technologies. The total number of firms in the sample is 1136. The ID Start-up attribute has been used to distinguish the start-ups univocally by assigning a sequential number to each new start-up that got into the database. The ID in not the whole series of numbers from 1 to 1136. The continuous maintenance of the database implicates the removal of the companies that no longer exist because of unsuccess or acquisition and the addition of new firms that have the characteristics of interest to be included. At the moment the ID in database ranges from 1 to 2899, however these numbers have little interest in terms of descriptive analysis, their role is to help treating the start-ups univocally.

As said above the firms in the sample were born recently following a global trend of innovation in the AI technologies. It includes start-ups founded from 2005 to April 2019. By computing the age in years from the foundation date declared in Crunchbase data it has been found an average of 5.64 years. The distribution of the firms by age is mostly skewed to the lower values as showed by the first quartile in *table 4.9*. The average is close to the median, with the 30% of the firms belonging to the age range from 4 to 6 years, as it can be seen in *figure 4.1*. The graph

of age distribution in ranges gives an immediate perception that the firms are for the most part in a pre-mature phase, with 510 firms founded in the last 5 years, which is almost half of the sample. Not surprisingly AI start-ups are innovative firms borne in recent years whose appealing projects are attracting several venture capital investment series setting record in the whole industry. The expansion of the market along with the positive rates of success can be hinted by the low number of firms receiving investments during the later stages of development. It means that there are many new entrants, therefore ground for improvement, the incumbent firms are still developing projects that need financing, and when the technology reaches completion the start-up is acquired by a larger firm.

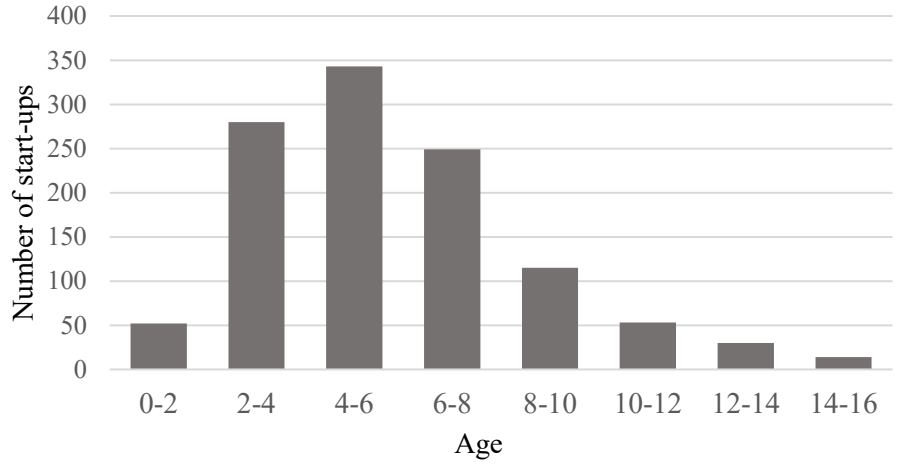
Table 4.9

Start-up age distribution in years

Value	Age
Minimum	0.88
I quartile	3.73
Median	5.15
III quartile	7.15
Maximum	15.16

Figure 4.1

Distribution of start-up age

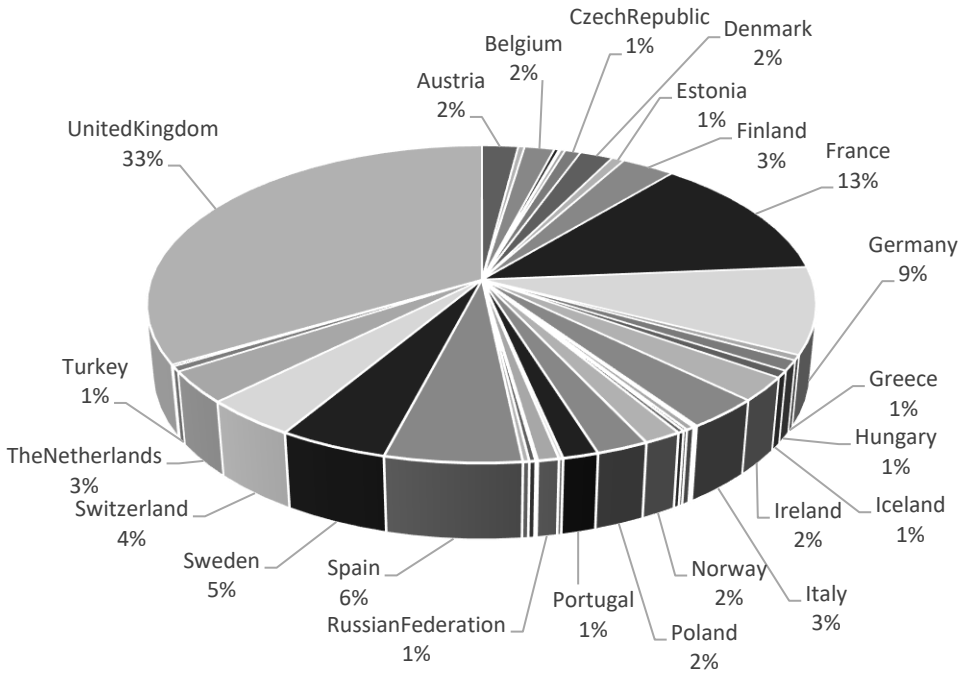


About the geographical distribution of the headquarters location the sample includes only data about European start-ups. On the whole 37 nations are represented, but with 55% of the firms belonging to United Kingdom, France and Germany. The most represented is the United Kingdom with 380 start-ups, then France with 143 and third Germany with 100. As showed by

figure 4.2 there are three large slides and several minor contributions from many countries, with some significative amounts in Spain Sweden, Switzerland, Italy and Netherlands.

Figure 4.2

Start-up geographic distribution per nation



When it comes to the activities for which the AI is designed the sample here is a good indicator of where the majority of the innovation is going. Whereas the data about the sector attribute provide an overview on the main industries in which the AI technologies under development find the most suitable applications. It has to be pointed out that 234 start-ups had no data about activity and sector and were not considered in the following statistics as they would have only diluted the results.

The distribution across sectors is displayed in *figure 4.3*. The top three industries which show the highest frequencies in the sample are health with 97 firms account for the 11%, IT 84 firms account for the 9%, and financial 68 firms account for the 8%. Not surprisingly the top three sectors have always been traditionally data driven. The health industry is probably less data intensive than IT and finance, but recently many machine learning algorithms are being used in drugs development, diagnosis and treatment analysis. Other relevant industries in which AI technologies are growing are connected to innovations in other technological trends such as internet of things (IoT) for mobility and manufacturing sectors whereas the extensive use of social media for customer service and HR.

Statistics about the activities showed in table 4.10, in which it is given the details about the distribution across sectors and the human interaction. The first three columns show the number

of start-ups developing a given type of AI and the next two show among them which are meant to increase human capacities and which replace the human activity. The market is clearly dominated by the augmented analytics with 257 firms account for the 29% of the total. The latter is the use of AI for data preparation and processing in order to obtain small but valuable sets insights from large and chaotic datasets. Therefore, augmented analytics AI finds wide use in helping the work of data scientists who spend most of their time in data collection and preparation. As a matter of fact, the 70% of such technologies increases human capacity. The other main categories of activities are the document analysis with the 13%, image analysis with the 11% and social behaviour with the 10%, that are more balanced in terms of increasing and replacing the human capacity. The document analysis is much more distributed across industries, it has a good share of applications in the financial industry accounting for the 22% of activities in such industry, in which prevails the augmented analytics technology with the 63%. While the image analysis finds useful applications in many areas with the highest values in health and mobility, the social behaviour AIs represent half of the advertising and education applications and more than one third of the marketing. Other high correlations are between the accounting and document analysis, customer service and chat analysis, legal and document analysis.

Figure 4.3

Start-up sector distribution

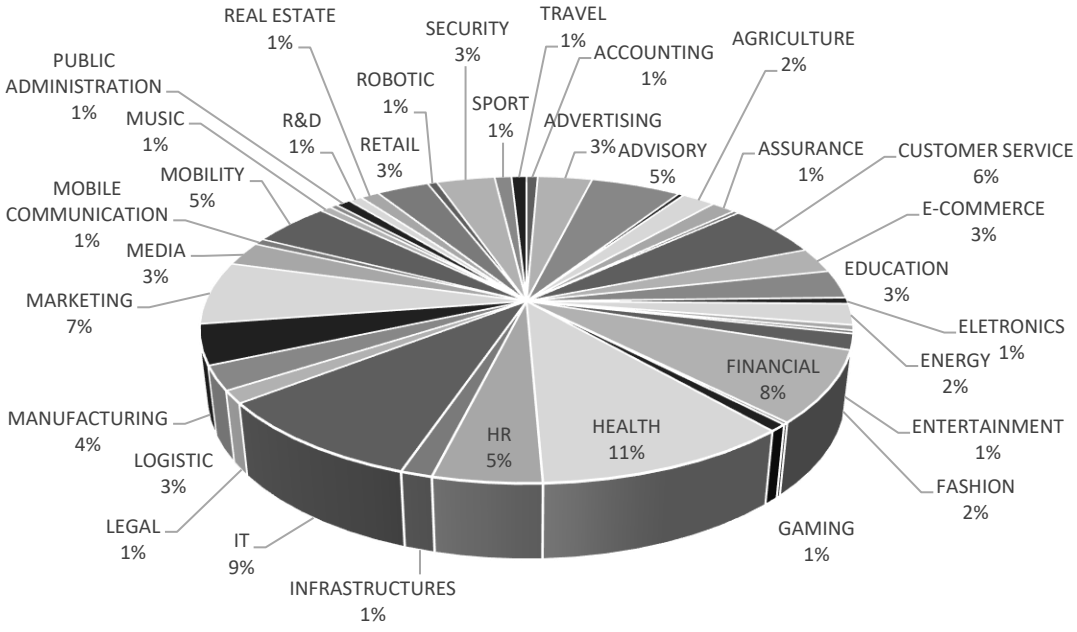


Table 4.10

Start-up distribution across activities and sectors

			Human Capacity		Sector																																						
		total	Increase	Replace	ACCOUNTING	ADVERTISING	ADVISORY	AEROSPACE	AGRICULTURE	ASSURANCE	BETTING	CUSTOMER SERVICE	E-COMMERCE	EDUCATION	ELETRONICS	ENERGY	ENTERTAINMENT	ENVIRONMENT	FASHION	FINANCIAL	FOOD	GAMING	HEALTH	HR	INFRASTRUCTURES	IT	LEGAL	LOGISTIC	MANUFACTURING	MARKETING	MEDIA	MOBILE COMMUNICATION	MOBILITY	MUSIC	PHOTO	PUBLIC ADMINISTRATION	R&D	REAL ESTATE	RETAIL	ROBOTIC	SECURITY	SPORT	TRAVEL
	3D REPRODUCTION	23	15	8			1							2		1			4				2			2		2	4									4	1				
	AI TRAINING	32	28	4			1													1			1			27														1	1		
	AUGMENTED ANALYTICS	257	177	80	1	1	7		5	6	3	3	4	2	3	15			2	43	1	1	41	12	2	17		10	6	29	3	3	10			5		2	4		4	6	6
	CHAT ANALYSIS	69	21	48			2		1	2		34	1	3						2			10	2		4				1	2	1						1	1	1			1
	COMPUTER VISION	72	38	34		2	3	2	2				2			1	2	1	1			3	9	3		6		4	3		4	1	13			1		1	3	1	2	2	
	CONSULTING	22	22	0			19																			3																	
	DOCUMENT ANALYSIS	129	73	56	5	1	5		3	1		1	4	3		1	1			15			7	20	2	11	12	4	1	5	8			1		1	6		7		3		1
	DRUG DESIGN	8	7	1																			8																				
	EYE-TRACKING	8	6	2		2	1							1									1			2											1						
Activity	FACIAL SCAN	9	5	4			1												1							1					1		1						2		2		
	IMAGE ANALYSIS	87	45	42		5	1	1	6	1			2	2		2	1		6	1		1	16		4	4		1	4	3	1		13		1			1	6	1	3		
	MOUSE TRACKING	1	1	0		1																																					
	PHOTO EDITING	5	3	2		1																									1				3								
	PREDICTIVE MACHINERY MAINTANANCE	14	10	4						1																1		1	10				1										
	SENSOR MONITORING	33	15	18					1			1			2		1	2			1		1		4			1	10		1	1	2	4								1	
	SOCIAL BEHAVIOUR	88	51	37		15	1			1		5	9	13	1				1	2		1	1	4		3				21	1		1	1		1			4		2		
	VOICE ANALYSIS	22	12	10		1	5					7	1	1								1				2					1		1					1		1			
	WEB VULNERABILITY	23	14	9			1			1			1							4						1				1											14		
				total	6	29	48	3	18	13	3	51	24	27	6	20	5	3	15	68	2	7	97	41	12	84	12	23	38	60	23	6	42	6	4	8	7	10	28	5	31	9	8

4.2.2 Investors

The investors considered in the sample were involved at least in one of the funding operations with the start-ups. Over the period of 15 years under analysis it has been collected data about a total of 406 investors. The numbers of investor type categories as described in table 4.6 are showed in the graph of figure 4.4. The statistics were highly predictable given the high-risk and potential high-growth characteristics of AI technology. Unsurprisingly, venture capitals lead accounting for half of the investors in the sample. The other main categories nearly at the same level are business angel, accelerator, private equity and government office. It is quite surprising to see a consistent share of funding coming from governmental authorities such as National Centres of innovation of Poland and Iceland or even the European Union. Between the international bodies the most active one seems to be The Executive Agency for Small and Medium-sized Enterprises (EASME) set up by the European Commission in 2004 to manage funding programs aimed at research and development, innovation, but also environment and climate change.

In figure 4.5 it is showed the nationalities distribution between the investors' entity. There are not only European investors as it can be immediately seen; the second largest share, after UK with 30%, comes from USA investors. European investors represent the majority being the 83% and between the non-European investors USA accounts for 75%. Mainly due to historical reasons it is not unexpected to find USA venture capitals, traditionally the most experienced in the industry, in second place overall and predominantly first between the extra-Europe investors. Not visible in the pie chart because of their small percentage it is interesting to notice investors coming also from other continents such as 13 firms form Asian countries and 1 from Australia.

Figure 4.4

Investor type distribution

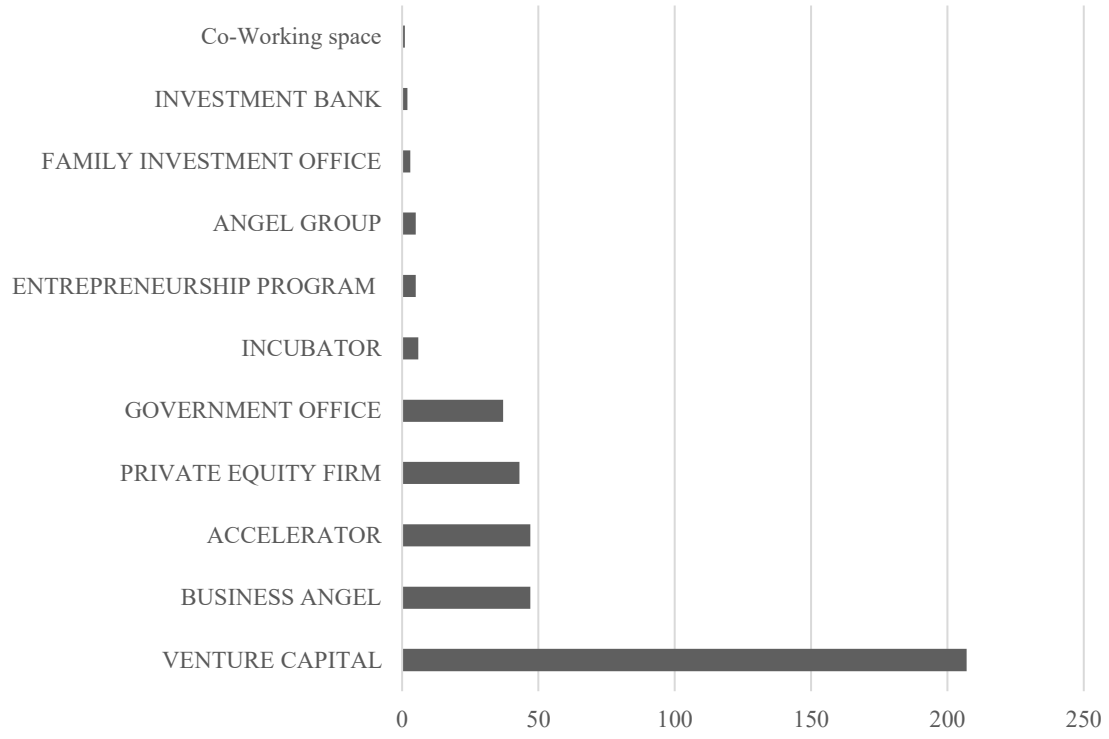
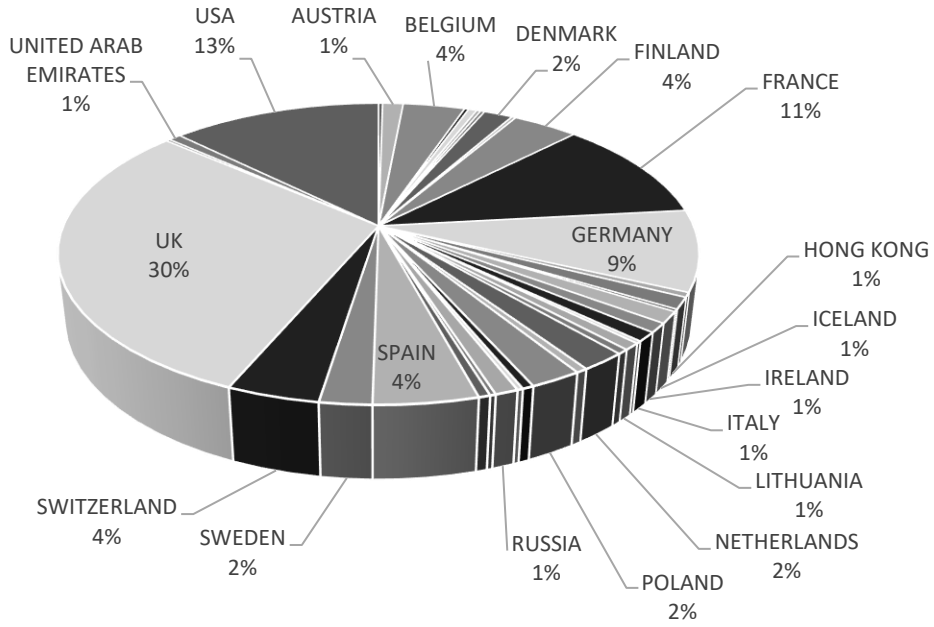


Figure 4.5

Investor nationality distribution



It is showed, in table 4.11 below, the amount of capital committed in each funding round, and the average investment per deal. The largest investments are made in the second round, despite the number of deals in the first one being higher. The average amount invested per deal unsurprisingly is higher in the third round, when the firm is showing promising performances and the biggest investors kick in. The astonishing insight is the fact that the whole investments in the third round raised more money than the second round with less than half of the deals. This means that on average the third-round investments are more than two times larger than the previous.

The lower part of the table shows the relative subdivision of the investment between the investor type categories. All the results coherently reflect the traditional strategies adopted by each different investor category. Venture capitals tend to focus on the second round of investments, they are early stage investors but in several cases their funding comes in after a previous investment. On the contrary business angels, commonly known to be one of the first sources of capital for a new-born start-up, have a decreasing trend. Accelerators show the same preferences of being first round investors, as their services besides from financing are aimed at emerging companies. The opposite trend in showed, rightly, by private equity and government offices, whose higher risk aversion makes them more active in the third rounds.

However, it has to be pointed out that, the fact that venture capitals are mostly active in the second round, and given the high percentage of such investors in the sample, the influence of their investment strategies highly influences these results.

Table 4.11

Fundraising distribution among types of investors and funding rounds

	Round 1	Round 2	Round 3
Number of deals	154	141	66
Total amount raised [M$]	569.858	946.894	456.903
Average investment per deal [M$]	3.70	6.72	6.92
Venture Capital	46%	52%	49%
Business Angel	16%	9%	3%
Accelerator	14%	11%	10%
Private Equity Firm	9%	12%	18%
Government office	9%	8%	15%
Incubator	2%	2%	1%
Angel Group	1%	2%	1%
Entrepreneurship program	2%	2%	0%
Family investment office	0%	0%	3%
Investment bank	0%	2%	0%
Co-Working space	1%	0%	0%

4.2.3 Deals

During the 15 years horizon it has been invested a total of $9.45 billion in the sample firms. For the following statistics it has only been considered the amount expressed in USD in order to aggregate values of the same currency. *Figure 4.6* shows the cumulated growth of committed capital and the amount raised each year. It can be seen how the effects of 2008 recession hit the market discouraging the investments in such risky technological developments. Eventually the recovering was short to come and 2013 saw the largest amounts of capital commitments with a total of $ 2.22 billion invested. The fundraising of AI start-ups considerably intensified in the last decade, as the amount of investments of 2013 represents two thirds of the total. The fact abovementioned demonstrates that AI development is going through an initial phase of growth of investors' interest.

Table 4.12 shows the investment in each stage, in each year, and its percentage with respect of the total of that year. Since the data about the stage of development was partially incomplete it is missing the category for some of the deals. The most relevant stages are the early stage and the late stage ventures, with respectively 30.53% and 27.44% of the total. For what concerns the average amount of capital per deal, in accordance with expectations it is increasing with the growth stage, as the entrepreneurs' need of financial resources grows with time. Seed capital has an average of $1.68 per deal and moving to the early stage the value soars to $12.66 million per deal. The late stage category has a total of 23 deals with an average of $112.79 million per deal. This category contains the largest deals of all, as a matter of fact, the high overall values of 2013 can be explained by the presence of large late stage venture investments of respectively $635 million and $310 million.

Figure 4.6

Fundraising per year and cumulated

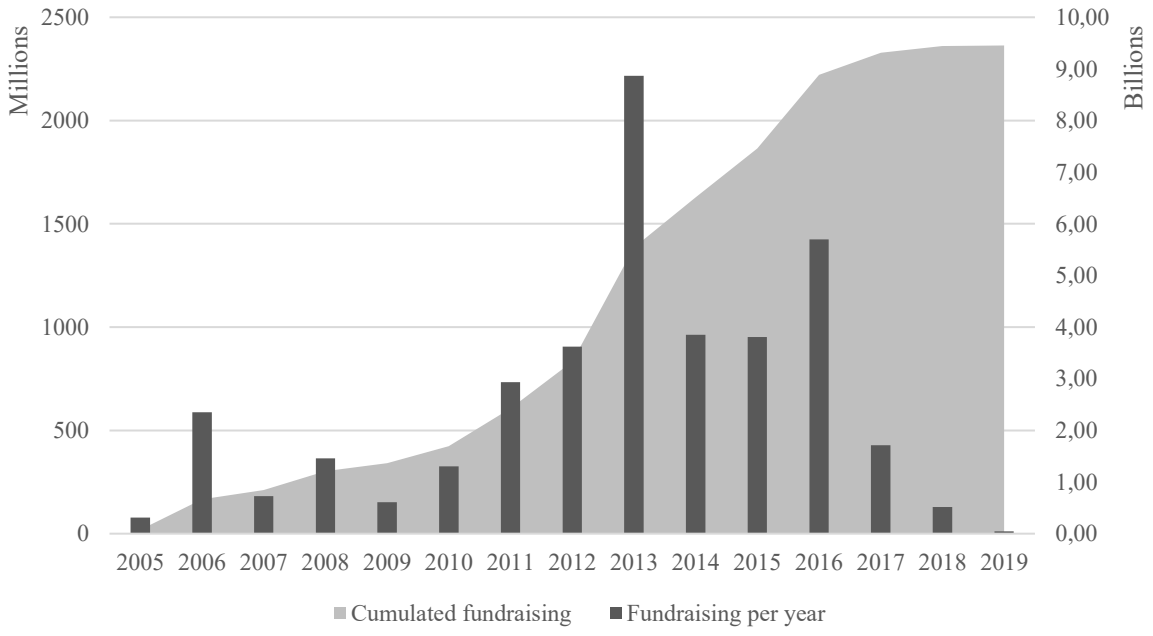


Table 4.12

Investments per year and stage (data in million $)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Total number of deals	6	11	15	18	21	36	49	93	125	162	179	194	151	63	13	**Total amount invested**
Early Stage Venture	42.37	2.00	79.20	80.11	48.78	132.91	241.13	307.94	284.70	475.72	578.28	436.27	140.03	36.51	-	2,885.96
	54.56%	0.34%	43.60%	21.96%	31.99%	40.75%	32.90%	34.03%	12.84%	49.43%	60.75%	30.63%	32.69%	28.15%		30.53%
IPO	-	22.90	-	93.16	-	-	-	-	40.27	-	-	-	-	29.00	-	185.33
		3.89%		25.53%					1.82%					22.36%		1.96%
Late Stage Venture	-	45.32	56.09	-	11.62	83.11	251.89	249.80	1,145.31	99.99	47.58	603.43	-	-	-	2,594.14
		7.71%	30.87%		7.62%	25.48%	34.37%	27.60%	51.66%	10.39%	5.00%	42.37%				27.44%
M&A	-	1.12	25.53	138.05	29.97	24.10	133.01	56.63	34.75	24.61	4.17	4.50	18.82	-	-	495.24
		0.19%	14.05%	37.84%	19.66%	7.39%	18.15%	6.26%	1.57%	2.56%	0.44%	0.32%	4.39%			5.24%
Private Equity	-	5.00	-	-	-	2.86	24.00	-	43.15	-	57.63	2.85	-	-	-	135.49
		0.85%				0.88%	3.27%		1.95%		6.05%	0.20%				1.43%
Seed	0.37	-	5.91	4.93	10.86	13.60	20.54	90.69	73.42	123.58	166.60	249.61	156.06	61.27	5.58	983.02
	0.48%		3.25%	1.35%	7.12%	4.17%	2.80%	10.02%	3.31%	12.84%	17.50%	17.52%	36.43%	47.24%	49.67%	10.40%
missing	34.92	511.71	14.94	48.59	51.24	69.60	62.32	199.91	595.34	238.44	97.63	127.69	113.47	2.92	5.66	2,174.40
	44.97%	87.02%	8.23%	13.32%	33.61%	21.34%	8.50%	22.09%	26.85%	24.78%	10.26%	8.97%	26.49%	2.25%	50.33%	23.00%
Total amount invested	77.67	588.04	181.68	364.85	152.47	326.17	732.90	904.97	2,216.94	962.34	951.89	1,424.36	428.37	129.70	11.24	9,453.58

5. Results and discussion

This chapter is aimed at showing the results and comparisons of the empirical research regarding the preferences about syndicating investments of venture capitals and the effects on the start-ups.

The main concept on which this thesis is based is to slightly deviate the common understanding of the syndication practice amongst venture capital firms. The scientific literature and research conducted on the subject matter focused on syndication as a tool to improve the venture selection (Brander et al., 2002), its impacts on the post-investment phase, especially in the joint-management process (Wright and Lockett, 2003) and the determinants leading to the alliance (Lockett and Wright, 2001). The research papers focused on diversification, on the other hand, usually take into account the syndication, but only as a control variable or descriptive statistic, while addressing the impacts of other diversification variables.

This thesis focuses on the investment phase. It is studied the moment when the start-up receives funding from an inter-firm alliance aimed at sharing the profits. Neither the phases leading to the co-investment decision nor the post-investment phases are under analysis. The management practices of such investor-investee relationships are not investigated. Whereas the market value of the firm post investment not sampled, thus the only information to assess the performance of the portfolio companies is given by the CB Rank attribute.

The concept of syndication in this thesis is modified and linked to the diversification strategies of venture capitals investments. Specifically, it is meant to understand the syndication as one of the possible ways to diversify the portfolio of equities held by the venture capitalist. Most of the times the syndication is driven by one or more of the following needs.

a. Receiving an informative second opinion over a possible investment from an additional venture capitalist at the same level or better, leveraging the complementary managerial set of skills as well.
b. Increasing the number of equities of a fund that can be bought with a limited amount of financial resources.
c. Risk pooling the factors associated to the single venture, reducing the overall portfolio exposure to firm-specific risks.

The analysis reverses the understanding of syndication practices and utilizes the diversification as a starting point for the study, given the alternative understanding of such processes and focusing on the second and third drivers mentioned above.

Initially it will be proposed a set of hypotheses derived from the insights collected and in chapter 3 where the main results of literature review have been presented. The hypotheses have been formulated with an eye on previous body of literature along with the specificities of the present case. The thesis attempts to draw conclusions in a confined portion of the broad industry of

venture capitals and innovation funding and eventually to generalize such results with all the due proportions.

The hypotheses are then tested with an empirical analysis conducted on the sample of data described in the previous chapter. Initially it will be used the whole sample to draw conclusions on the patterns of syndication and the implied relationships with other variables. Subsequently, it will be done a comparison between the investor types and a focus on the venture capitals.

5.1 Hypotheses

Hereunder are presented a set of hypotheses following previous research. The majority of the work of study related to the three main concepts of venture capitals, syndication and start-ups has been performed with a generic scope on various industries and technologies. This time it has been decided to focus on the investors backing the development of AI technology and the related entrepreneurial companies. Therefore, the generic theories and results of the authors that have been mentioned across chapter 3 have been interpreted considering the specificities of the sample under analysis.

As demonstrated by many researches, syndication structures are a common practice and account for a significant amount of deals in the venture capital market. The need of sharing knowledge and skills pushes towards the establishment of horizontal associations between syndicate partners. The need is strictly linked to the objective of being able to create value for the firm in order to manage and accelerate its growth. Investors are predominantly moved by the exit prospects, while the start-ups, recipients of the financial resources, benefit from the value added. Therefore, admitting that syndication of investments in innovative industries gathers all the benefits discussed in paragraph 3.5, on average it should be able to foster growth of start-ups and increase their value. Based on these considerations it has been formulated the first hypothesis.

H 1: syndication is associated with greater start-up performance

Taking the other point of view of venture capital investments and portfolio construction, the concerns in risk and uncertainties push towards syndication as well. In such cases the view the investor has of the co-investment shifts towards the achievement of the financial portfolio benefits of diversification. As said in the introduction of the chapter, the two main reasons by which a venture capitalist might be willing to form an investment alliance is to either increase the number of securities and consequently to fragment the shares of firm-specific risk. Under such understanding of syndication as a strategy to increase diversification a second hypothesis can be formulated. Given that it is under analysis a field of high-tech development, the risk associated to the AI technology is on average amongst the highest on the market. Therefore, it is expected an extensive use of syndicated deals rather than standalone investments.

H 2: syndication is more common than single investors in backing AI start-ups

From the descriptive analysis presented in chapter 4 it has been drafted a view over the characteristics of the innovation market beyond AI technologies. It is a market characterised by young firms, as the average of the age is 5.64 years with a distribution significantly skewed to the lower values. There are start-ups belonging to different stages of development, but the majority of the funds have been raised during the seed, early and late stage. Respectively accounting for $900 million in the seed stage and more than $2 billion in both early and late stage. During the seed stage generally the first round of institutional financing is provided, companies are still too young and uncertainty about the successful development of a viable business is high. Specifically, to the development of AI technologies, there is a significant difficulty in making realistic predictions about the evolution of the development phase. The technological risk associated belongs to the riskier groups being almost impossible to visualize ex-ante the applicability of a given activity performed by an AI technology in a given sector. As described in paragraph 2.3.1 this is usually the stage where the first round of financing is provided by a single investor, which in case of entrance of other players takes on the role of lead investor. During the early stage it should be more frequent to find co-investment alliances. The technology should be more directed towards a feasible application, therefore, attracting more interest from other investors. However, the presence of a remaining high share of risk might be a driver for an extended amount of syndicated deals, because of the need of reducing portfolio exposure by the means of risk pooling. In paragraph 2.3 it has been described the differences between the stages of development and it has been showed that the later ones are characterised by lower risk, once the technological and market uncertainties have been overcome, the presence of larger international players and less need of diversification. For these reasons, the late stages might be characterised by larger investments and lower syndicating partners, as showed by table 4.11 the larger investors like private equity whose preference are on later rounds of financing with lower number of deals, but higher average of capital committed. Based on the above-mentioned considerations, the third hypothesis is formulated here below.

H 3: syndicated deals are mostly present in the early stages

In chapter 4, where it has been showed a set of descriptive statistics of the companies and the investors, emerged a great variety in terms of geographical location. 37 different European nations are represented among the start-up entity, whereas the investor entity represents in a global scale a total of 36 nations. Many studies pointed out the impacts of proximity between investor and investee. It is demonstrated that distance between physical locations of both counterparties impacts the performance of start-ups and their growth. For the sake of an efficient management of the company and a continuous and accurate controlling the proximity to the venture location is a matter of strategic success for a venture capital. Furthermore, when the physical accessibility to the portfolio company is eased the investors have lower logistical complexity and lower costs, therefore, being able to dedicate more time to nurturing the company. As it has been estimated that on average fund managers have restricted time to be spent with each portfolio company the possibility of being financed by an investor located in the same country is viewed as an advantage from start-ups. This condition is not always possible as sometimes the investor seeking for the most suitable investment opportunity targets a

company outside its country borders. While start-ups, especially on a larger scale, might receive financing offerings in line with their requirements only from foreign investors, with whom are going to be partnering despite the physical distance. In such cases, to mitigate the downside of distance in a syndicated investment with a partnership of international players, having an investor located closer to the start-up might be a key of success in the management phase. Therefore, the following hypothesis predicts that it is more probable to be supported by a national investor when a co-investment partnership is created around a start-up.

> **H 4**: start-up receiving syndicated investments have better chances to be financed by a local investor

In conclusion the effects of syndication should provide benefits in both direction of the business created around the technology innovation. As discussed, the syndication is intended as a strategy of investors to enhance venture selection process, achieve superior management competences and diversify portfolios by risk pooling. Start-ups benefit from a greater value added with a more comprehensive set of capabilities and multiple sources of financial resources. In view of the facts discussed above, it can be assumed that the presence of co-investment deals backing a start-up creates a framework of collaboration and superior value added in which both sides, for instance investor and investee, extract greater benefits.

> **H 5**: syndication creates a win-win situation for start-ups and investors

The hypothesis here formulated have been tested using the data of the sample previously described. In the next paragraphs are showed the results and statistics of the empirical analysis on the data along with the description of the construction of related variables. The first part focuses on the investor-investee relationship, subsequently the focus shifts on subsets of the sample following the entities' categories described in chapter 4.

5.2 Effects on start-ups

It has been decided to begin the analysis with an assessment of the dynamics of investors' syndication with other distinctive indicators. In order to verify patterns of investments and related effect it has been computed a correlation matrix among a set of variables describing the features of the investment deals on AI European start-ups. The sample has been taken as a whole with no data manipulation. Then it has been decided the set of variables to be analysed in order to spot significative patterns in the investments. As showed in table 5.1, the variables considered are syndication, start-up age, Crunchbase Rank, total funding amount and start-up development stage.

The syndication variable has been computed as a dummy taking the value of 1 for the syndicated deals and the value of 0 for the standalone investments. It has been possible through the deal's entity attribute number of investors.

From the foundation date it has been computed the age of the start-up at the moment of the funding, as it has been done for the statistics showed in table 4.9 and figure 4.1.

The Crunchbase rank as defined in paragraph 4.1.1 is the ranking assigned by the online platforms' algorithm to evaluate the attractiveness of the company. It has been used to give a quantitative evaluation of the company's performance, thanks to its ability to score the companies, prioritizing in ascending order the most relevant ones. Being the Crunchbase rank based on an ordinal value, therefore with lower valued indicating higher performances. For such reasons, it has been converted into a negative variable in order to associate the increase in value with an increase in the performance.

The total funding amount is the value in US dollars of the money raised by the company in each deal. The data was taken as it was reported in the sample under the corresponding deals entity attribute.

The development stage represents at which stage of the growth of the company the funding occurred. It has been created an ordinal scale variable on the basis of the funding status attribute of the deal entity. It has been assigned a unitary increase starting from a value of 1 for the seed stage. It has been assigned the same level for the top two stages, which are the IPO and M&A, being two mutually exclusive ways of concluding the cycle of development financing.

Table 5.1

Correlation matrix

		1)	2)	3)	4)	5)
1)	Syndication	1.0000	0.1084	0.3841	0.1304	0.1169
2)	Age		1.0000	-0.0547	0.1539	0.2260
3)	CB Rank			1.0000	0.2451	0.0812
4)	Total Funding Amount				1.0000	0.1580
5)	Development stage					1.0000

The correlation matrix suggests the presence of a significative relationship between syndication and the CB rank. It means that in general the start-ups performing on the higher parts of the ranking are more likely to be financed by a syndicated round of financing. The results seem to support an evidence of the first hypothesis, however, to strengthen the relationship between the two variables an in-depth analysis has been performed. Correlating the CB ranking with the number of players co-investing in the same start-up it has been found a correlation coefficient of 0.4261, whose positive and even larger value gives an additional demonstration of a strong relationship between the variables. Table 5.2 below shows the results of the comparison performed between the deals co-invested and the standalone financing deals. The first result to show a preference regarding co-investment is the higher number of such deals. With 738 operations this category accounts for 65% of the total, demonstrating a general tendency to syndication regardless of geography, industry or development stage. The latter result supports

hypothesis 2. In the following paragraphs patterns in such clusters will be analysed in detail. On the whole, syndicated deals have on average a lower rank which can be translated in better performance and, at the same time, they are able to raise higher amounts of capital.

Table 5.2

Comparison of syndicating and non-syndicating deals

	Non-syndicating deals			Syndicating deals		
	Obs.	Average	Std. Dev	Obs.	Average	Std. Dev
CB Rank	398	41257.18	20328.62	738	24349.28	18860.46
Total Funding Amount [million $]	398	2.817	6.330	738	11.29	37.831

With the results of both tables discussed above, it has been showed a general preference of investors in jointly investing in the European AI start-ups and creating more value, therefore, hypothesis 1 can be considered confirmed.

In table 5.3 it is showed a detail of distribution of syndicated and non-syndicated deals above and below $10 million. It furtherly demonstrates the inclination to raise larger amounts of capital, which is without any doubt a positive force towards innovation financing.

Table 5.3

Syndicating deals above and below $10 million

	Total Funding Amount	
	<$10 million	>$10 million
Syndicating	50%	2%
Non syndicating	33%	15%

5.3 Development stage clusters

In order to test the third hypothesis about a wider use of co-investment in the earlier stages of development, given the larger impact of technological and market risk. Accepting the fact that syndication can be used as a strategy to diversify away the risk associated to the single firm, but as more efficient tool for start-up selection in the screening phase, it is expected a decreasing trend with the increase of the development stages. The sample has been divided in 3 main cluster of development stages: Seed Stage, Early Stage, Later Stages. The latter includes also the categories of IPO, M&A as such large deals are commonly to happen in the vary late stages

of growth of a company, when maturity of the business has reached a significant level. By computing the percentage of syndicated deals over the total of each of the three stages it has been found that the seed stage is characterised by a significative percentage of syndicated deals. In the two following stages the percentage severely drops. The table 5.4 here below displays the results.

Table 5.4

Syndicating deals percentage across stages clusters

	Deals	
	Syndicating	Non syndicating
Seed Stage	44%	56%
Early Stage	17%	83%
Late Stages	19%	81%

It has been showed that investors tend to co-invest more in the seed stage rather than the later stages. The connection of syndication to the higher risk associated to the initial period of a venture seems to be supported by the results above even though the correlation analysis has not showed a significative level. Looking for additional support for the hypothesis it has been done a deeper breakdown of the dynamics of each stage. In table 5.5 it is showed a summary of values of descriptive statistics in each cluster. It has been investigated the total funding amount, the number of investors and the share of funding invested by each investor on average, which is simply the ratio between the two. Contrary to expectations, the average number of investors is lower in the seed stage despite a much larger percentage of syndicated deals. The results suggest a majority of syndicated deals in the seed stage but with smaller groups. There could be many reasons behind such facts, for instance the later stages, as it can be seen, on average raise higher amounts therefore more investors are needed to provide such larger capitals. Companies in mature stages might be in need of such larger funds due to expansion projects, and a single investor might not be in the condition to satisfy that need alone. Another reason could be that in seed stage investors are pushed back from investing on their own primarily for evaluation and asymmetries problems. It could be the case in which the first of the syndication drivers, described in the chapter's introduction, is predominant. For these reasons hypothesis 3 has been considered partially confirmed.

Table 5.5

Stage clusters descriptive statistics

Seed Stage				
	Average	*Std.Dev.*	*Min*	*Max*
Funding Amount	1.680	1.883	0.2	17.300
Number of investors	3.222	2.527	1	20
$ per investor	0.911	1.302	30209	13.121

Early Stage				
	Average	*Std.Dev.*	*Min*	*Max*
Funding Amount	12.657	12.053	0.522	69.269
Number of investors	5.850	4.618	1	37
$ per investor	3.341	5.080	0.112	55.000

Late Stages				
	Average	*Std.Dev.*	*Min*	*Max*
Funding Amount	37.067	84.500	0.2	635.313
Number of investors	5.304	5.793	1	35
$ per investor	7.26	13.985	0.107	79.414

5.4 Proximity between investors and companies

As seen from the statistics about companies and investors the market analysed had a wide international scope. Investors consider financing companies from various countries and start-ups are reached from many international players. It has been discussed that being financed from an investor in the same country could represent an advantage for both parties due to physical proximity. It has been found that 61% of the companies is financed at least by one local investor.

To evaluate the correlation between the syndication and the probability of securing an investment from a local investor it has been divided the dataset in country clusters from the point of view of the start-ups. Then it has been linked with the entity investor looking for correspondence with the country attribute. For the sake of significance, it has been taken into account only the countries in which there were at least 10 active investors. Including countries with just one company would have distort the analysis. In table 5.5 it is showed for each country the number of investors and between those the percentage belonging to the same country of the start-ups of the given country. In the next column it is showed the percentage of syndicated deals for each country. It can be seen that the percentages of local investors are generally equally distributed among countries. The majority has a percentage close to the whole dataset average. The countries accounting for the majority of data, such as United Kingdom and France have a percentage at least as high as the average. In the third country by number of investors, Germany, the percentage is lower. The implied relationship between syndication and probably of receiving investments from local investors is more clearly displayed by figure 5.1, where the

data of table 5.6 has been plotted. In the system of axis, it can be visually detected as the points of the countries where there is a higher degree of syndication show greater probabilities of securing capital from local investors. The latter result confirms hypothesis 4.

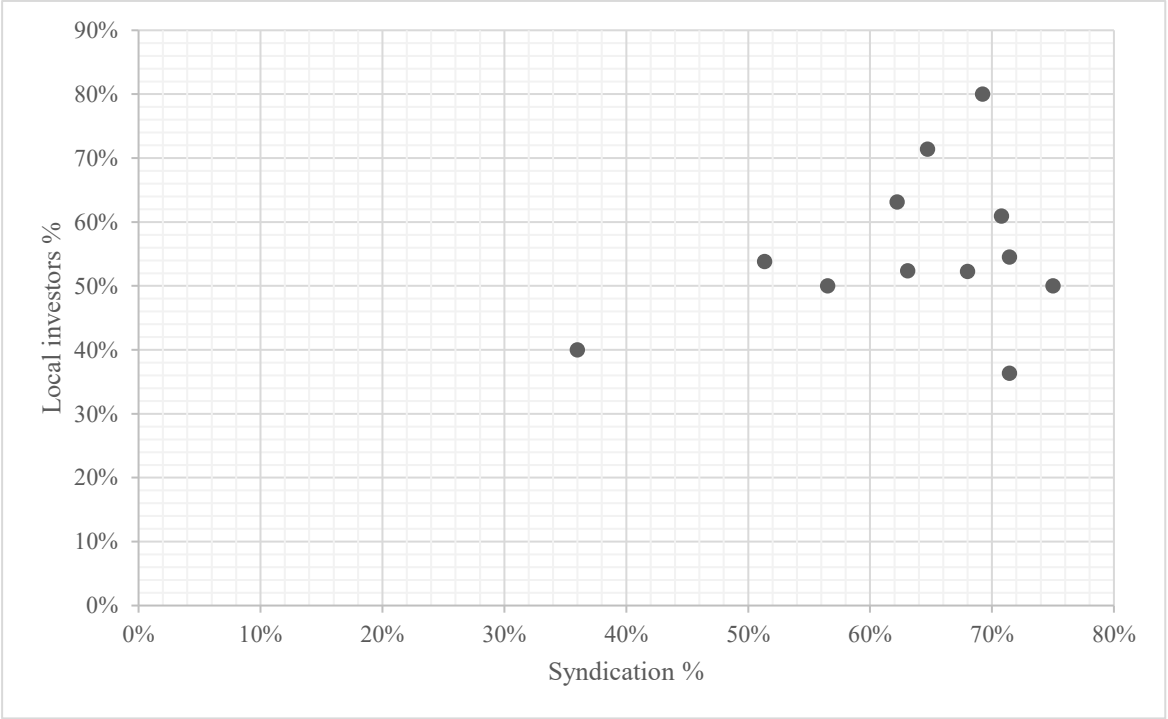
Table 5.6

Same country investors percentage

	n investors	% same country	% syndication
Austria	10	50%	57%
Denmark	11	55%	71%
Finland	21	71%	65%
France	50	80%	69%
Germany	44	52%	68%
Ireland	11	36%	71%
Poland	15	40%	36%
Spain	11	52%	63%
Sweden	12	50%	75%
Switzerland	19	63%	62%
The Netherlands	13	54%	51%
United Kingdom	169	61%	71%

Figure 5.1

Local investors percentage



5.5 Effects on venture capitals and other investors

It has then been decided to compare the statistics across the various categories of investor type. Only the most significative categories have been considered. Data about Incubators, Entrepreneurship Programs, Angel Groups, Family Investment Offices, Investment Banks and Co-Working spaces was not sufficient to be compared to the other categories. The remaining have at least 37 active investors in the sample start-ups, which are reasonably enough to be compared to venture capitals, accounting for 207 different investors. In order to assess the mutual relationships between start-ups and investors, the two entities have been linked through a unique key that represented the deal between investor and investee. In this way it was possible to associate a given start-up to multiple investors and on the contrary an investor with all the start-ups financed.

Table 5.7 displayed below provides a summary of the investor types showing the percentage of syndicated deals over the total. It is also showed the average amount invested by a single investor. The syndicated deals for each investor type have been identified and divided by the total in order to make comparisons across investor types and stages in relative terms. It has been done the same aggregation in development stage clusters as in paragraph 5.3, in order to group together the later stages.

Not surprisingly the accelerators show the lowest average investment amount, while the highest is represented by the private equity firms. In fact, the latter usually target later stages companies and dispose of larger financial resources. The surprising result is the large average invested amount by business angels, which is close to the private equity firms one. They have proven to be the second most active type of investors behind venture capitals but also the more concerned investor type with syndication with the high amount of capital committed in the seed stage. On the other hand, private equity, as expected, has the lowest percentage of syndicated deals. The business model of such enterprises, as discussed in the introductory chapter, is less exposed to risk, therefore, less inclined to diversification. Venture capitals have a medium high average of capital invested and a considerable share of syndicated deals. Across the three stages considered venture capital's syndicated deals are more balanced than the other investor types, suggesting a systematic approach to co-investment as a strategy to reduce risk exposure.

Looking at the percentages of syndication through the stages there is a clear decreasing path. With the only exception of private equity firms, which has the highest share of syndicated deals in the early stage, all the other types of investors tend to syndicate much more on the seed stage, a little less in the early stage and even less in the late stages. These findings are useful to support hypothesis 3 which had been left as an open point partially confirmed. Thus, it can be stated that syndication is more frequent in the deals involving firms at the initial stages of growth. Further confirmation of the understanding of syndication as a strategy of diversification comes from the latter results, given the inverse relationship between development stages and risk.

Table 5.7

Investor type syndication distribution

	Average $ per Investor	Syndication %	Syndicated Deals		
			Seed	Early Stage	Late Stages
Venture Capital	20.880	80%	50%	39%	12%
Business Angel	33.354	87%	68%	24%	7%
Accelerator	6.719	72%	71%	24%	6%
Private Equity Firm	34.881	56%	33%	42%	25%
Government Office	31.052	68%	56%	36%	8%

In order to assess the impact on the side of investors it has been decided to focus on the cluster of venture capital investors. The database has been filtered and only the deals involving financing from venture capital firms have been selected. Linking the entities of start-up, investor and deal, it has been possible to evaluate correlations involving unmatched attributes. Table 5.8 below displays the correlation coefficients found by comparing syndication variable with the development stage, Crunchbase rank and total funding amount. The syndication variable in this case has been considered not as a binary variable like in table 5.1, it has rather been evaluated as the number of other investors involved in the deal. The development stage and the Crunch base rank are attributes related to the underlying companies in which each venture capital has invested. Whereas the funding is the total amount raised in the investment deal. The latter does not show significant correlation with the syndication variable, probably indicating that larger amounts of capital to be allocated are not influenced by the co-investment strategies. Whereas both the development stage and rank of the underlying start-ups are positively and significantly correlated to the syndication variable. The first result suggesting that the syndication is more related on the later stages dales is a little in contrast with the findings of the previous analysis where it was showed a higher amount of syndicated deal in the seed stage. Since here it has been considered an alternative variable to evaluate syndication the result suggests that the deals in the early and later stages on average involve more syndicated partners than the seed stage. In the latter it is more common to find co-investments between a couple of investors who support each other in the start-up screening and selection phase. Whereas on the next two stages not exempt from risks the syndication involves more investors in order to exploit the risk pooling benefits. As a matter of fact, the average number of investors per deal, considering only the syndicated ones, in 3.9 in the seed stage, 7.3 in the early stage and 13.1 in the later stages.

Table 5.8

Venture capital's syndication correlation

	Dev. Stage	CB Rank	Funding
Syndication	0.3856	0.4315	0.2725

Lastly the significative correlation with the rank of the start-up suggests that syndicated deals are related to start-ups with higher ranks and thus higher performances. Together with the findings of paragraph 5.2 it is, therefore, possible to state that hypothesis 5 is confirmed. The strategies of syndication have positive influences on both sides since the companies receiving capital from a group of heterogeneous investors is more likely to increase its value and reach the desired objectives. On the other side investors have on their portfolios a share of a company which attractiveness is more likely to increase in the future, leading to successful exits.

5.6 Conclusions

In this thesis it has been addressed the topic of diversification in the context of innovation financing, more specifically in the venture capitals' investments. The idea was born from the consideration of venture capitalist as risk adverse financial intermediaries. Just like other risk adverse investors, it is common practice to allocate the wealth under management in funds containing multiple assets in which to distribute the shares of capital. Supported by the traditional financial portfolio theories, diversification of the investments plays a significant role in the investment decision making, as each venture is not considered as a standalone commitment of risk capital but rather as part of a more complex medium-long term plan. The literature review provided great understanding on the reasons and strategies of venture capitals regarding diversification of their funds. Between those strategies, one of the most common is the syndication or the co-investment between two or more investors. The study of this thesis begins with the premise that the decision of syndicating an investment comes from the need of reducing risk and asymmetries. Given the great level of risk associated to the common venture capitals investments the syndication serves as a strategy for reduction of the fund's exposure through the risk pooling.

Along the lines of methodologies shared by various researches on similar subject matters it has been performed an empirical analysis. The data set used included data about European start-ups developing AI technologies which have been financed by venture capitals and other types of high-risk investors. The database maintained by Politecnico di Torino had collected information about 1136 start-ups on a time interval of 15 years. The analysis began with the formulation of a set of hypotheses, on the basis of the knowledge collected reviewing the literature and considering the specific context in which the sample had been built. It has initially considered the whole set of deals included in the database to draw high-level conclusions. Then it has been done a comparison of the diverse types of investors which provided financial resources to the start-ups under investigation. Lastly it has been focused the analysis on the venture capitals and their patterns of syndication.

To assess the effects on start-up performance of syndication strategies it has been analysed the correlation between the variables in table 5.1. The results demonstrated that greater start-up performance is associated in the majority of the cases with syndicating investors. The expectations were confirmed, as it has been remarked several times the great deal of benefits that a syndicating structure of investors backing a start-up provides to the development of high-risk projects. The field of artificial intelligence technologies regardless of the industry in which

it finds application is associated with a not insignificant amount of uncertainty. The result is in line with the expectations for two reasons. First the syndicated deals are helpful during the venture selection phase, therefore, only the most solid business plans get to be financed, which in turn entails lower rates of project mortality. Secondly, the shared management is able to create higher value thanks to a larger and more heterogeneous set of resources and capabilities. The in-depth comparison between syndicated and non-syndicated deals showed in table 5.2, provided positive results on both variables of funding and rank. Both variables suggest that syndicated deals on average raise larger capital and create more value. The larger variability of the funding of syndicated start-ups might suggest that those kinds of deals are scattered around the average, therefore also accounting for several deals raising smaller amounts of capitals. Since the standard deviation is not able to give an idea on where is mostly concentrated the dispersed data, if skewed to lower values, higher values or symmetrical to the average, it has been analysed in further detail dividing in two groups of funding. As table 5.3 shows the great majority of syndicated deals are above $10 million, with only the 2% below, confirming that syndication is able to provide larger financial resources in the context of innovation technologies.

In paragraph 5.3 it has been divided the sample into stages clusters in order to assess the dynamics of each one. It has been found that syndication decreases with the development stage while non syndication increases, in accordance with the premise that earlier stages are subjected to higher risk therefore the need of syndicating an investment is stronger. The deep dive in each stage assessing also the number of investors and the average dollars invested by each one provided further proof that the seed stage is characterised by smaller groups. Whereas the later stages, where higher amount of capital are raised, the co-investment structures are larger.

It has been found that there is a significant correlation between syndication and the probability that a start-up secures capital form a local investor. In the sample, 61% of the start-ups are backed at least by one local investor and the implied relationship with syndication can be visually seen with the points plotted in figure 5.1.

Lastly it has been compared the statistic of the most relevant investor types. For instance, it has been considered only the categories with at least 37 active investors. Table 5.7 confirmed that venture capitals are the most active investors in the market followed by business angels. Venture capital firms have a high aptitude towards syndication and a systematic approach in every development stage. Whereas other types of alternative finance sources tend to concentrate them on a given stage. For example, business angels that are mostly active in the seed stage, tend to have higher syndicated deals in such stage, whereas private equity firms tend to shift towards later stages. Focusing on the venture capitals and the relative start-ups that received funds it has been assessed the correlation of syndication with other variables. It was found that the size of the total amount of capital committed is not significantly influenced by the co-investment strategy. On the other hand, the syndication is highly correlated with the rank of the underlying start-ups therefore higher performance and higher value is created. The latter result at least for venture capitals confirms the win-win situation created by the syndication strategies put in place by venture capital investors.

It is showed in table 5.9 below the summary of the hypothesis formulated along with the outcomes of the analysis that have been used to test them.

Table 5.9

Hypotheses summary table

	Hypothesis	Outcome
H 1	syndication is associated with greater start-up performance	confirmed
H 2	syndication is more common than single investors in backing AI start-ups	confirmed
H 3	syndicated deals are mostly present in the early stages	partially confirmed
H 4	start-up receiving syndicated investments have better chances to be financed by a local investor	confirmed
H 5	syndication creates a win-win situation for start-ups and investors	confirmed for venture capitals

5.7 Future Studies

The study here performed has been limited by the amount of data contained in the sample. It is therefore a suggestion for future studies to perform similar investigations expanding the scope. First it could be of much interest to assess the syndication dynamics in the context of other innovative start-ups. The sample of AI developers has been useful to prove hypothesis in a field of innovation highly subject to uncertainty. Other start-ups and the relative investors may have different approaches and effects, therefore, this study could be used to make a comparison.

From the perspective of the investors it could be of great interest to see the relationship between syndication and the other diversification strategies. This thesis has linked the performance of start-ups to the performance of the investors. A further analysis can be done addressing more focus on the composition of the funds of venture capitals, comparing the performance of the specialised with the generalists. Gathering data about the exits could be expand the study to the post-investment phases to see the impact of strategies that are basically put in place during the investment decision-making in the whole lifecycle of the fund.

Since it is demonstrated that syndicating an investment is helpful when dealing with the portfolio company issues during the monitoring phase, further study can be done addressing the trade-off between the time dedicated managing and the value created. Few studies have been conducted on how can be efficiently divided the effort to nurturing a start-up. Understanding the trade-off between coordination costs and diversification it could be suggested a set of best

practices for the creation of risk-reward balanced portfolios and the joint management of the companies. Lastly, given the trade-off between coordination costs and diversification and assumed that diversification has a positive impact on returns, it could be studied at which point diversification is not convenient anymore because of the increased costs and complexity.

Bibliography

James R. Bartkus M. Kabir Hassan, (2009),"Specialization versus diversification in venture capital investing", *Journal of Financial Regulation and Compliance*, Vol. 17 Iss 2 pp. 134–145

Barnett WP, Greve HR, Park DY. 1994. An evolutionary model of organizational performance. *Strategic Management Journal*, Winter Special Issue 15: 11-28

Brander, J., Amit, R., Antweiller, W., 2002. Venture-capital syndication: improved venture selection vs. the value-added hypothesis. *J. Econ. Manage. Strategy* 11 (3), 423–452.

Bygrave, W. Spring 1987. Syndicated investments by venture capital firms: a networking perspective. *Journal of Business Venturing* 2(2): 139-I54.

Buchner A., Mohamed A., Schwienbacher A., 2017. Diversification, risk, and returns in venture capital. *Journal of Business Venturing*

Caselli S., Negri G., 2018. *Private Equity and Venture Capital in Europe, Markets, Techniques and Deals*. Academic Press, Elsevier Ltd.

Checkley M., Añòn HigÓn D., Angwin D., 2010 Venture Capital Syndication and Its Causal Relationship with Performance Outcomes. *Strat. Change* 19: 195–212

Clercq, D. D., V. H. Fried, O. Lehtonen, and H. J. Sapienza. 2006. An Entrepreneur's Guide to the Venture Capital Galaxy. *Academy of Management Perspective* 20(3):90–112.

Clercq, D. D., and H. J. Sapienza. 2005. "When Do Venture Capital Firms Learn from Their Portfolio Companies?" *Entrepreneurship Theory and Practice* 29(4):517–35.

Cressy, R., Malipiero, A., Munari, F., 2014. Does VC fund diversification pay off? An empirical investigation of the effects of VC portfolio diversification on fund performance. *Int. Entrep. Manag. J.* 10, 139–163.

Dal-Pont Legrand M., Pommet S., 2010. Venture capital syndication and the financing of innovation: Financial versus expertise motives. *Economics Letters* 106 (2010) 75–77

Deli D., Santhanakrishnan M., 2010. Syndication in Venture Capital Financing. *The Financial Review* 45 (2010) 557–578

Gerken L. C., 2014. *The Little Book of Venture Capital Investing*. John Wiley & Sons, Inc., Hoboken, New Jersey

Gompers P., Lerner J., 2001. The Venture Capital Revolution. *Journal of Economic Perspectives*. Volume 15, Number 2-Spring 2001: 145-168

Gupta, A., & Sapienza, H. (1992). Determinants of venture capital firms' preferences regarding the industry diversity and geographic scope of their investments. *Journal of Business Venturing*, 7, 342–362.

Ingram P, Baum JAC. 1997. Opportunity and constraint: organizations' learning from the operating and competitive experience of industries. *Strategic Management Journal*, Summer Special Issue 18: 75–98.

Klonowski D., 2018. *The Venture Capital Deformation, Value Destruction throughout the Investment Process*. Palgrave Macmillan, Springer International Publishing AG, Gewerbestrasse 11, 6330 Cham, Switzerland

Lauterbach R., Welpe I. M., 2007. Performance differentiation: cutting losses and maximizing profits of private equity and venture capital investments. *Fin Mkts Portfolio Mgmt* (2007) 21:45–67

Lockett, A. and M. Wright, 2001. The syndication of venture capital investments, *Omega* 29, 375– 390.

Matusik, S.F., Fitza, M.A., 2012. Diversification in the venture capital industry: leveraging knowledge under uncertainty. *Strateg. Manag. J.* 33, 407–426.

Mathonet P., Meyer T., 2008. *J Curve Exposure, Managing a Portfolio of Venture Capital and Private Equity Funds*. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England

Merton, R. July 1987. A simple model of capital market equilibrium with incomplete information. *Journal of Finance* 42(3): 483-510.

Norton, E., Tenenbaum, B.H., 1993. Specialization versus diversification as a venture capital investment strategy. *J. Bus. Ventur*. 8 (5), 431–442.

Palepu, K. 1985. "Diversification Strategy, Profit Performance and the Entropy Measure." *Strategic Management Journal* 6(3):239–55.

Wright M., Lockett A., 2003. The Structure and Management of Alliances: Syndication in the Venture Capital Industry. *Journal of Management Studies* 40:8 December 2003

Yang, Y., Narayanan, V.K., De Carolis, D.M., 2014. The relationship between portfolio diversification and firm value: the evidence from corporate venture capital activity. *Strateg. Manag. J.* 35, 1993–2011.

Zhang P., 2014. Understanding Diversification Strategy in Venture Capital Market. *Entrepreneurship Research Journal*. 2014; 4(3): 277–296

Zider B. 1998. How venture Capital Works. *Harvard Business Review*. November December 1998: 131-139

Sites

https://en.wikipedia.org/wiki/Venture_capital

https://www.investeurope.eu/

https://nvca.org/

https://mooreks.co.uk/services/advisory/corporate-finance/raising-finance-growth-capital/alternative-sources-finance/

https://strategiccfo.com/alternative-forms-of-financing/

http://www.ovcf.com/VentureCapital/IndustryOverview/tabid/67/Default.aspx

https://home.kpmg/xx/en/home/campaigns/2019/10/venture-pulse-q3-2019.html

https://www.forbes.com/sites/johngreathouse/2012/09/18/pssst-heres-how-to-become-a-venture-capitalist/#32abfa6d1de1

http://www.businessdictionary.com/

https://www.morganstanley.com/ideas/venture-capital-funding-gap

https://www.bain.com/insights/adjacency-strategy-global-private-equity-report-2019/

https://www.forbes.com/sites/bizcarson/2019/02/06/ubers-secret-gold-mine-how-uber-eats-is-turning-into-a-billion-dollar-business-to-rival-grubhub/#489a1a7d1fa9

https://yourstory.com/2018/12/lead-investor-lets-break

https://venturebeat.com/2020/01/14/ai-startups-raised-18-5-billion-in-2019-setting-new-funding-record/

https://www.wonderflow.co/blog/what-is-augmented-analytics-in-less-than-3-minutes

https://www.inc.com/business-insider/industries-under-threat-artificial-intelligence.html

https://hbswk.hbs.edu/item/government-funded-research-is-increasingly-funding-corporate-innovation