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REPUTATION, VC FUNDING, AND INNOVATION
EVIDENCE FROM THE UK MICRO AND NANOTECHNOLOGY SECTOR

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Abstract

Startups' contributions on economic growth have been widely realized. However, the funding gap is often a problem limiting startups' development. To some extent, VC can be a means to solve this problem. VC is one of the optimal financial intermediaries for startups. Two streams of VC studies are focused in this dissertation: the criteria used by venture capitalists to evaluate startups and the effect of VC on innovation.

First, although many criteria have been analyzed, the empirical assessment of the effect of startup reputation on VC funding has not been investigated. However, reputation is usually positively related with firm performance, which may affect VC funding. By analyzing reputation from the generalized visibility dimension and the generalized favorability dimension using a sample of 200 startups founded from 1995 operating in the UK MNT sector, we show that both the two dimensions of reputation have positive influence on the likelihood of receiving VC funding. We also find that management team heterogeneity positively influence the likelihood of receiving VC funding.

Second, studies investigating the effect of venture capital on innovation have frequently resorted to patent data. However, innovation is a process leading from invention to successful commercialization, and while patents capture the upstream side of innovative performance, they poorly describe its downstream one. By reflecting the introduction of new products or services trademarks can complete the picture, but empirical studies on trademarking in startups are rare. Analyzing a sample of 192 startups founded from 1996 operating in the UK MNT sector, we find that VC funding has positive effect on the propensity to register trademarks, as well as on the number and breadth of trademarks.

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1 Introduction

1.1 Objectives of the dissertation

Startups are important in economic growth and development. New ventures especially technology-based ones are often associated with new technology applications, leading to increased innovation and competition within the market place and finally stimulation of industry evolution and increased economic growth; in addition, startups are associated with creating new job positions (Loveman & Sengenberger, 1991; Wong, Ho, & Autio, 2005). Even recently, the industry structure is shifting toward the formation of new ventures from established large incumbents (Carree & Thurik, 2010).

However, startups face several problems in their early phases, which limit their ability to grow. There is a well known funding gap for such types of companies, although venture capital (VC) financing can be a means to solve this problem. There has been a wide literature on VC, such as the development of VC markets (Gompers & Lerner, 2001; Gompers, 1995), how VC funds operate (Fried & Hisrich, 1994; Timmons & Bygrave, 1986), what determine VC investment decisions (MacMillan, Siegel, & Subbanarasimha, 1985; Franke, Gruber, Harhoff, & Henkel, 2008; Fried & Hisrich, 1994; Petty & Gruber, 2011), which is the impact

for the performance of VC backed companies (Baum & Silverman, 2004; Bertoni, Croce, & D'Adda, 2010; Grilli & Murtinu, 2012), etc. In this dissertation we focus on two streams of this literature: first, the criteria used by venture capitalists to evaluate startups, and then the impact of VC funding on innovation.

In fact, we are interested to assess whether and how the reputation that new ventures are able to create in the early phases of their development, help them in attracting VC funding. We also look at a specific instrument which might help new firms to construct their reputation in the market and protect their innovative outputs, namely registered trademarks.

As concern the first contribution of this dissertation, even though scholars have listed many criteria used by venture capitalists to evaluate startups (MacMillan et al., 1985; Muzyka et al., 1996; Franke et al., 2006; Haeussler et al., 2008; Petty & Gruber, 2011; Hoenig & Henkel, 2012), to our knowledge there hasn't been a direct empirical assessment of the role played by a startup's reputation on facilitating the obtainment of VC funding. The criteria generally studied in the literature on venture capital funding can be grouped in two levels: generic criteria level and specific criteria level. Management team, financial returns, product offering (Franke, Gruber, Harhoff, & Henkel, 2008; Petty & Gruber, 2011), and alliances (Baum & Silverman, 2004) constitute the generic criteria emphasized by venture capitalists in their investment decisions. Moreover, when making decisions, venture capitalists also consider their own investment strategy on industry focus, geographic area, financing stage, and so on. In addition, studies further investigate some specific criteria deeply, for instance, management team characteristics, such as experience and background (Meyerinck, Oesch, &

Schmid, 2012).

Nevertheless, there are no empirical studies investigating the role of reputation on VC funding. In this dissertation we thus build on a more general stream of the literature on company reputation (Barnett, Jermier, & Lafferty, 2006; Caruana, 1997; Lange, Lee, & Dai, 2011; Rindova, Ian, Antoaneta, & Sever, 2005; Zyglidopoulos, 2001), and use the following definition of reputation: "reputation is characterized by a level of visibility with the organization, beliefs about what to expect from the organization in the future, and impressions about the organization's overall appeal" (Lange et al., 2011). As an important intangible asset, reputation has many merits making it a potential criteria used by venture capitalists. Startups with favorable reputation may be more likely to get access to other critical resources (Fombrun & Shanley, 1990), to build strategic barrier for competitors (Deephouse, 2000), and to charge above average price on their products (Stephen, 2001). In a word, reputation is positively related to firms' future performance (Bergh, Ketchen, Boyd, & Bergh, 2010; Boyd, Bergh, & Ketchen, 2010). Suppose firm performance is one of the most important factors influencing VC funding, it is reasonable to believe that reputation may be an important criterion used by venture capitalists to screen their investment opportunities.

In this dissertation, we study the role of reputation on the receipt of VC funding, considering two different dimensions of reputation: generalized visibility and generalized favorability. Generalized visibility is about the extent to which a startup is known by stakeholders and generalized favorability is about the extent to which a startup is given favorable judgments by stakeholders (Lange et al., 2011). In addition to that, we also take into

account the effect of top management team composition, which is particularly relevant for VC investment choices, according to previous literature for new ventures

The first empirical study of the thesis thus address the above mentioned issues, using data from a sample of 200 new ventures founded from 1995 operating in the micro and nanotechnology sector in the United Kingdom through the period from each startup's founding year until December 31, 2010. In order to create measures for the different dimensions of reputation, we refer to previous studies referring to media coverage (Deephouse, 2000) for what concern the generalized visibility dimension and generalized favorability dimension. More specifically, generalized visibility is measured by the number of news in the media; and generalized favorability is measured by the coefficient of favorableness, which reflects the extent of how favorable a startup is and is calculated through differentiating news into favorable, unfavorable and neutral ones. Then the management team heterogeneity is proxied by team occupational background heterogeneity.

As concern the second major contribution of the dissertation, we refer to the rich literature on the influence of VC funding on innovation (Bertoni et al., 2010; Bertoni & Tykvova, 2012; Engel & Keilbach, 2002; Hellmann & Puri, 2000; Kortum & Lerner, 1998; Peneder, 2010). The literature suggests that venture capitalists are active investors providing support for their portfolio companies and increasing their innovative output (Baum & Silverman, 2004; Bertoni et al., 2010). In this literature, most scholars have used measure based on patent data as a proxy for innovation outcomes, thus explicitly referring to a technical dimension of innovation. However, patent only reflects the invention stage of the

innovation process, but do not capture in an adequate way the commercialization stage of innovation. Patented inventions, in fact, can generate returns only when they are commercialized into the market, and it is well known in the literature that many patents are not commercially exploited by companies or they are characterized by very limited economic value (Gambardella, Giuri, & Luzzi, 2007; Munari & Sobrero, 2011). A recent and growing stream of the literature has focused on trademarking in order to capture more directly the firms' ability to commercialize and promote new products or services into the market (Jensen & Webster, 2011; Rujas, 1999). Registered trademarks are a sign which serves to allow consumers to distinguish the goods or services of one firm from those of others. Previous studies have convincingly shown that new trademark filings is usually related with introduction of new products by companies (Mendonça, Pereira, & Godinho, 2004; Schmoch & Gauch, 2009), so that trademarking can be used as a complementary measure of innovation. As a second contribution of the thesis, we thus investigate the effect of VC funding on the trademarking activities of start-up companies. The objective is to assess whether the likelihood to file for trademarks and the trademarking intensity of new ventures increases after the receipt of VC funding, also in comparison to a control group of companies which were not funded by VC investors. Moreover, we are interested in assessing whether the receipt of VC funding has also an impact on the breadth of trademarks registered by a new company, as captured by the number of different NICE classes.

In order to address the above mentioned research questions, we use a sample of 192 new ventures established from 1996 from the same sample of firms operated in the UK MNT

sector over the period from each startup's founding year until December 31, 2011, and collect data for trademarks from the UK Intellectual Property Office (IPO) and the Office for the Harmonization of Internal Markets (OHIM). The empirical results of our regression analyses indicate that VC funding is positively related with the likelihood of trademarking, the number of trademarks and the breadth of trademarks. Therefore, this suggests that venture capitalists' suggestions, involvement and commitment facilitate startups' innovation, and their tight monitoring stimulates startups' incentives toward innovative performance. VC funding is thus an important factor influencing innovative performance especially successful commercialization of innovations for startups.

To sum up the contributions we intend to give to the existing literature on new ventures and venture capital funding, with the first empirical study about the role of reputation on VC funding we intend to provide three types of contributions. First, it is one of the first to investigate the relationship between reputation and VC funding. Previous studies analyzing the relationship between reputation and stakeholders are mainly about reputation and consumers, such as Caruana (1997) and Rindova et al. (2005); while the relationship between reputation and external investors is limited. Second, we investigate the effect of team heterogeneity on VC funding. There are some studies analyzing the effect of team heterogeneity on firm performance, such as Hambrick, Cho and Chen (1996), Jehn et al. (1999), and Giuri et al. (2010). However, the knowledge about the effect of team heterogeneity on VC funding is rare in the literature. Third, we measure two dimensions of reputation, providing a multidimensional perspective on reputation and stressing its

importance for a complete understanding on the VC investment decisions.

The contributions of the second empirical study on the effects of VC funding on trademarking activities can be seen from two aspects. First, in our knowledge, our study is the first to focus on the trademarking activity of high-tech new ventures and tracing its link to VC funding. We thus contribute to a rapidly expanding literature on trademarking activity of companies (Greenhalgh & Longland, 2009; Greenhalgh & Rogers, 2012; Helmers & Rogers, 2010; Millot, 2009; Sandner & Block, 2011), which has largely neglected so far the behavior of new ventures in this respect, but it has rather focused on large and established companies. Second, although this literature has mainly focuses on the characteristics of the industry (such as "high-tech" vs. "low-tech") or on the characteristics of the company (such as company size, innovation intensity) to explain the propensity to trademark, we provide evidence that the financial sources used by a new venture, and in particular the recourse to VC funding, can be another important determinant of startups' trademarking activities.

Except for the theoretical contributions, several anticipated managerial implications and policy implications could also be drawn from this dissertation. First, this dissertation has anticipated managerial implications for both startup entrepreneurs and VC managers. As for the anticipated managerial implications for startup entrepreneurs, we expect startup reputation is important in attracting VC funding and startup entrepreneurs should then take some actions in order to build favorable reputations. Given that reputation is multi-dimensional and the resources is limited in startups, startup entrepreneurs could resort to build favorable reputation in one dimension first and then build other dimensions of

favorable reputation gradually. Moreover, we expect VC funding has positive influence on startups' trademarking activities. If so, when choosing between VC funding and other financial resources, the contribution of VC funding on trademarking activities should be considered by startup entrepreneurs.

As for the managerial implications for VC managers, if reputation is important, startup reputation should be another criterion they use to assess startups. In addition, to help startups in enhancing their trademarking activities, VC managers need to train their employees toward having strong capabilities in commercializing inventions.

Second, this dissertation also has some anticipated policy implications for the government. Startup reputation is expected to have positive influence on their access to VC funding. VC funding is expected to help startups enhancing their trademarking activities. If so, the government need to make some policies help startups to build favorable reputation and help them attracting VC funding. For example, the government could create a platform facilitating the interactions between VC managers and startup entrepreneurs.

1.2 Structure of the dissertation

The rest of the dissertation is organized as follows. Chapter 2 gives a brief literature review. We first explain why VC funding is an optimal financing intermediary for startups. Then we review the criteria used by venture capitalists to evaluate potential deals. Finally the effect of VC funding on innovation is briefly reviewed. Through literature review, we find that the role

of reputation as a criterion on VC funding has not been investigated, especially regarding the two general level dimensions of reputation (generalized visibility and generalized favorability), and there is no research analyzing the effect of VC funding on trademarking, rather than patenting, activities. Therefore, we intend to do two empirical studies on these two gaps based on a sample of startups in the UK micro and nanotechnology sector.

Chapter 3 gives a brief presentation of the context of the dissertation, the micro and nanotechnology sector, especially for what concerns the case of the United Kingdom. Chapter 4 is the first empirical study addressing the role of reputation on the access to VC funding. Chapter 5 is the second empirical study analyzing the effect of VC funding on trademarking activities. Finally, chapter 6 makes conclusions of both the two empirical studies (chapter 4 and chapter 5). Limitations of our researches and directions on future studies are also discussed in chapter 6.

2 Literature review

To investigate the role of reputation on the access to VC funding and the impact of VC funding on trademarking activities for startups, we consider two streams of VC funding literature in this dissertation: the criteria venture capitalists use to evaluate firms and the effect of VC funding on innovation. Therefore, this chapter gives a brief literature review on the two streams. We first introduce the characteristics of VC funding, why it is suited for startups, and then provide the criteria venture capitalists use to make investment decisions, and the impact of VC funding on startups' innovation.

2.1 Venture capital funding: characteristics and impact

Startups are generally subject to a liability of newness, a liability of smallness and greater variance of growth rates compared with established firms, thus with a lower likelihood of survival (Gilbert, McDougall, & Audretsch, 2006; Gruber, 2004), together with high uncertainty about the future prospects of young firms (Shane & Stuart, 2002), making the entrepreneurs facing with the task to signal the value of their firms when raising money (Higgins, Stephan, & Thursby, 2011).

In addition, entrepreneurs also need signals to overcome the problem of asymmetric

information between themselves and potential investors so as to obtain financing: on the one hand, because of the unique characteristic of the knowledge that it is easy to be copied, the inventors are reluctant to disclose the fully information to potential investors; on the other hand, once obtaining the financing, the inventors may engage in opportunistic behavior, which leads to investors' reluctant to finance new ventures (Shane & Cable, 2002).

As one group of investors, venture capitalists have some specific advantages to alleviate the asymmetric information problem between startups and investors. Venture capital can be defined as "independently managed, dedicated capital focusing on equity or equity-linked investments in privately held, high-growth companies" (Hall & Lerner, 2009).

This definition identifies some specific characteristics of venture capital investments, which make them particularly suited for new high-tech startups. First, their investments are mainly focused on early-stage firms and high-technology based industries (Gompers, 1995; Tyebjee & Bruno, 1984), since they are looking for investment opportunities characterized by significant growth prospects. Second, they provide capital in the form of equity making them share risks with portfolio firms and then have the incentives to help startups toward success (Amit, Glosten, & Muller, 1990). Third, they are active investors, so that they not only provide capital, but also strategic advice and support which is especially important for technology based startups because they are short of these capabilities internally (Baum & Silverman, 2004).

These specific characteristics make VC funds particularly suited to finance high-tech young companies, as compared to traditional investors such as banks. Banks usually lack the

necessary technical skills to evaluate projects (Gompers, 1995). In contrast, venture capitalists often possess relevant technical expertise needed to scrutinize the potential market value of the projects (Timmons & Bygrave, 1986).

Moreover, from the perspective of startups, venture capital funding is more beneficial for their future growth. Because of regulations, banks normally can only provide debt financing. On the one hand, debt-based bank financing strictly restrain the cash flow of firms (Jeng & Wells, 2000). On the other hand, high interest payments are always related with debt financing, which may cause liquidity problems for startups and limit their growth finally (Gompers, 1995).

Another source of financing is business angels, defined as wealthy individuals financing firms using their own funds. However, their investment scope is limited, due to limited individual wealth and limited number of wealthy individuals (Jeng & Wells, 2000). Compared with banks and business angels, on the one hand, venture capitalists' close interaction with startups may assist startups in improving managerial capabilities (Hellmann & Puri, 2000); on the other hand, as informed agents being able to pick up promising startups, the involvement of venture capitalists acts as a signal of startups' future success, which can enable startups to raise additional funds and obtain other resources. That is, venture capitalists act both as coach and as scout (Baum & Silverman, 2004). Projects financed by venture capitalists are characterized by higher returns, higher growth and larger size (Ueda, 2004). In conclusion, venture capital funding is the optimal source of funding for startups.

There has been a large literature over the last 20 years analyzing the characteristics,

investment behavior and impact of VC firms. Some studies have focused on the diffusion of VC investments in a given country, looking at the institutional and economic characteristics facilitating their presence, such as in the US (Gompers & Lerner, 2001), in the UK (Whitehead, 2003), in China (Chang, Wang, Chen, & Fu, 2010), etc. Some studies have looked at the management of VC firms, such as their structure (Sahlman, 1990), the governance of their investments (such as staged investments, syndication of investments, etc) (Gompers, 1995), and their performance (Krishnan & Masulis, 2011), etc. Some studies have investigated the investment process (Tyebjee & Bruno, 1984; Fried & Hisrich, 1994; Petty & Gruber, 2009) and the factors influencing VC decisions (Bottazzi, Da Rin, & Hellmann, 2011; Ebbers & Wijnberg, 2011; Haeussler, Harhoff, & Muller, 2008; Hsu, 2007; MacMillan, Siegel, & Subba Narasimha, 1985). Other studies have analyzed the impact of VC on innovation behavior (Bertoni & Tykvova, 2012; Kortum & Lerner, 1998; Moore & Wustenhagen, 2004; Penas & Da Rin, 2007) and firm growth (Baum & Silverman, 2004; Davila, Foster, & Gupta, 2003; Grilli & Murtinu, 2012; Peneder, 2010). In this chapter, we focus on two specific streams of the literature which are more directly linked to the contribution we provide in the following empirical chapters. Therefore, we first focus on the literature analyzing the criteria used by VC firms to select their investee companies and the determinants of VC funding. Then, we focus on the literature looking at the impact of VC funding on innovation outcomes of investee companies.

2.2 Criteria used by venture capitalists to make investment decisions

There is a long tradition to study the criteria used by venture capitalists to make their investment decisions. A wide variety of evaluation criteria could be grouped into two categories: startup internal characteristics and startup external alliance.

2.2.1 Criteria related with startup internal characteristics

In early studies, the criteria used by venture capitalists are identified by sending simple questionnaires to venture capitalists and ask them to rank the importance of various criteria. Through this method, Tyebjee and Bruno (1984) identify five basic groups of criteria used by venture capitalists: market attractiveness, product differentiation, managerial capabilities, environmental threat resistance, and cash-out potential. Similarly, by analyzing the questionnaire finished by one hundred venture capitalists, MacMillan et al. (1985) emphasize the quality of entrepreneurs as the most important criteria used by venture capitalists. The study by Muzyka and Biriley (1996) is done by interviewing seventy three venture capitalists from countries across Europe and asking them to complete a questionnaire. The final analysis shows that the management team criteria is the most important factor, and product-market criteria only have a moderate impact on VC funding.

However, this method is criticized on some points. First, this method only considers the

final decisions and does not consider the entire decision making process (Fried & Hisrich, 1994). Second, it is based on an assumption that venture capitalists remember very well about their decision processes. However, venture capitalists only have limited insight of their decision processes and they tend to report those criteria which they believe are desirable (Petty & Gruber, 2011). In contrary, the experimental method could overcome many of these problems since it is based on real-time data.

Fried and Hisrich (1994) use a case study methodology to address the problem of entire decision processes. They first propose fifteen generic criteria used by venture capitalists and explain the criteria based on three basic constructs: concept, management and returns. Then they develop a six-stage model of the decision making process: origination, venture capital firm-specific screen, generic screen, first-phase evaluation, second-phase evaluation, and closing. They emphasize that different activities are involved in each stage. For example, during the origination stage, venture capitalists emphasize the role of referrers; in the firm-specific screen stage, they require the proposals should be in line with their overall strategy in investment size, industries, geographic location and stage of financing; and then they evaluate the proposal according to the generic criteria; additional information is gathered from both company and outside sources by venture capitalists during the first-phase evaluation stage to determine whether the deal is serious interesting; in the second-phase evaluation stage, they begin to evaluate the obstacles of investment and how to overcome; finally, document negotiation is done in the closing stage.

Further, Petty and Gruber (2011) overcome the post-hoc problem through longitudinal

data containing 11 years archival information on a European-based VC firm. Similar to Fried and Hisrich (1994), they emphasize that the criteria used by venture capitalists changes in different stages of the decision making process. In detail, product characteristics is the primary criteria during the first six months of the decision making process; and financial valuation and deal structure are the main reasons for rejection in the latter stages. In addition, they argue that except for the basic criteria emphasized by other researchers, including criteria related to the product/service offering, to the market/industry, to the startup team, and to the financial returns, there are other important sets of criteria used by venture capitalists, including VC portfolio composition and VC management time. In terms of VC portfolio composition, venture capitalists require the proposals to meet their firm-specific criteria on product focus, geography and financing stage. In terms of VC management time, venture capitalists sometimes reject proposals simply because they do not have enough time to devote to a potential deal.

Except for these broad criteria on a general level, researchers also try to break them down into more specific factors over the last years and focus on criteria on a more specific level. Aggregate criteria are important to understand the overall evaluations investigated by venture capitalists. However, deeper insights can only be obtained from more specific analysis (Franke et al., 2008).

Because startups are resource limited, a few signal tools can be used by startups to attract VC funding. Management team and patenting are the two most popular factors having been investigated in the literature on the access to VC funding for startups.

First, the question about what team characteristics are more important for venture capitalists is investigated in the literature. Findings by Franke et al. (2008) reveal that of the seven team characteristics (relevant industry experience, field of education, university degree, leadership experience, mutual acquaintance, age of team members, and prior job experience), industry experience, educational background, and leadership experience are the most important ones emphasized by venture capitalists. Further, they show that it is enough if only some of the team members possess industry experience or leadership experience. However, as for the educational background, heterogeneous teams are preferred. Similarly, Hsu (2007) also emphasizes the positive effect of prior founding experience, especially financially successful experience, on the likelihood of receiving VC funding. Rather than educational background, Hsu (2007) analyzes doctoral degree related with founding team and provides support on its positive influence on VC funding. Same with Franke et al. (2008), Meyerinck, Oesch and Schmid (2012) also emphasize the effect of industry experience. They find that firms' announcement of a new director with industry experience positively influences investors' reactions. Further, they find industry experience as an executive director is more valuable than industry experience as an employee or an outside director. They demonstrate that director industry experience is important because of the advisory role of directors on senior management.

Moreover, Franke et al. (2006) propose that venture capitalists tend to provide investment to those firms having similar teams with themselves in terms of training and professional experience. Similarities in age, experience in leading teams and level of

academic education are not emphasized by venture capitalists.

Second, the question about what dimensions of team are emphasized by different categories of venture capitalists are investigated. Franke et al. (2008) differentiate venture capitalists into novice venture capitalists and experienced venture capitalists according to their experience. They find both groups emphasize industry experience and field of education. However, experienced venture capitalists emphasize mutual acquaintance among team members (team cohesion), while novice venture capitalists focus more on tangible individual-level characteristics, for instance, university degree.

Patenting is another important factor attracting VC funding in the literature. Patenting can be a credible signal because of the following reasons. First, it is costly for startups. The combined costs of direct monetary fees and indirect administrative costs associated with patenting process, such as understanding patenting rules and procedures, filing patent applications, defending the patents, are considerable for startups. Second, only those novel and practically useful inventions have the potential to be patented. Therefore, patenting is a good signal of firms' technological underlying quality and future market.

Empirically, the positive relationship between patent and VC funding has been investigated by several scholars, for instance Baum and Silverman (2004), Cao and Hsu (2011), and Audretsch, Bonte and Mahagaonkar (2012). In a study of biotechnology startups in Canada, Baum and Silverman (2004) prove that startups with patents are likely to obtain more VC funding. Similar results are shown by Cao and Hsu (2011). They provide evidence that startups having patent activities (measured with dummy patent and prior patent counts)

significantly influence their access to VC funding. In detail, patent dummy and prior patent counts are both significantly and positively related with the total amount of VC funds and the incubation period. Audretsch, Bonte and Mahagaonkar (2012) also confirm the positive influence of patents in nascent ventures on obtaining equity finance.

2.2.2 Criteria related with external alliance

Some characteristics related with the presence of external alliances make it an important signal for startups in attracting VC funding. First, external alliance facilitates a startup's access to other valuable resources and knowledge. Second, it is a signal telling venture capitalists some other actors evaluate the startup positively (Baum & Silverman, 2004).

Empirically, when investigating the effect of interfirm alliances on VC funding, Baum and Silverman (2004) propose to differentiate alliances into downstream, upstream, and horizontal alliances. They find that venture capitalists tend to invest more in startups with more downstream and horizontal alliances. According to their explanation, downstream alliances are associated with the access to complementary assets, like distribution channels, marketing expertise, and so on. All of these are necessary conditions for successful product development and commercialization. However, upstream alliances are related with the access to research know-how and technological expertise and they may make venture capitalists think that the startup is far from commercialization.

2.3 Impact of venture capital funding on innovation

It is widely believed by both scholars and practitioners that VC funding provides a substantial contribution on firms' innovations (Baum & Silverman, 2004; Bertoni et al., 2010; Kortum & Lerner, 1998; Kortum & Lerner, 2000). If we adopt the definition of innovation as "the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (Baregheh, Rowley, & Sambrook, 2009), the contributions of VC on innovation should be seen from two aspects: on the one hand, VC funding is believed to drive investees' to have more inventions; on the other hand, once giving investment, venture capitalists are motivated to help startups in increasing the velocity at which new inventions are commercialized (Timmons & Bygrave, 1986).

In the literature, the contributions of VC funding on startups' innovation is mainly related with the following reasons. First, venture capitalists could help startups in remedying their defects in limited funds and insufficient management experience. Startups are always financially constrained. The entry of VC funding thus provides them the opportunity to finance more inventions. In addition, due to their characteristic of newness, startups are usually weak in senior management, especially those from scientific environment, and venture capitalists could help them in this aspect, especially by providing some strategic suggestions. That is, there are some natural weaknesses limited startups' development and venture capitalists' entry could nicely offset these weaknesses and thus contribute to their

innovative outcomes (Bertoni et al., 2010).

Second, venture capitalists' tight discipline may lead to startup' greater innovation performance (Bertoni et al., 2010). Once receiving VC funding, startups may pursue harmful strategies on venture capitalists due to their different goals (Gompers & Lerner, 2001b). To protect their investments from opportunistic activities by startups, venture capitalists are motivated to monitor startups actively through several mechanisms such as stage financing and taking seats on the board of directors (Gompers, 1995). The tight monitoring may influence startups' innovative performance.

Third, venture capitalists' network is also beneficial for startups' innovative performance. VC backed startups are more easier to get access to other critical resources, such as potential customers and suppliers, additional funds, and reputational employees through venture capitalists' social network (Bertoni et al., 2010). As venture capital, additional funds make startups have the capability to finance more inventions. Reputational employees, especially reputational technological scientists, are important on making inventions.

However, on the other hand, negative effects may also be related with VC funding. First, venture capitalists and startups may have different objectives and strategies and these differences may lead to disagreements between venture capitalists and startup directors, which finally absorb startups' attention on pursuit of new technologies. Second, to avoid the possibility that venture capitalists poach the inventions and then exploit them by themselves, startups may mainly put the investments in improving and commercializing existing

technologies rather than in pursuing new inventions (Bertoni et al., 2010).

In the empirical studies, the inventions have been often reflected by the number of patents a firm has, such as Kortum and Lerner (2000), Lerner (2002), Bertoni, Croce and D'Adda (2010), although there have been also studies looking at other measures of innovation such as the number of new products introduced into the market (Hellmann & Puri, 2000; Peneder, 2010), R&D activities such as "make" or "buy" R&D activities (Penas & Da Rin, 2007), etc. The effect of VC funding on patenting can be summarized from two different study levels: the industry level and the firm level.

At the industry level, there is a common sense that the fast growing of venture capital industry in the USA has spurred innovation. In the seminal work investigating the impact of VC funding on innovation using data across twenty industries over the period between 1965 and 1992 in the USA, Kortum and Lerner (2000) provide evidence that VC funding does positively influence the number of patented innovations after controlling for R&D spending and the arrival of technological opportunities which could affect both VC funding and patenting.

With a dramatic fall of venture capital activities in the USA around 2001, Lerner (2002) investigates the influence of the decline of VC activities on innovation. He argues that the impacts of VC on innovation are not uniform across the cycles of venture activity. He finds that impact is attenuated in the boom period and the dire predictions are overstated in the bust period.

In addition to the study of the impact of VC on innovation in the industry level, some

researchers have discussed it from the firm level. In addition to analyze the impact of VC funding on innovation at the industry level, Kortum and Lerner (2000) also investigate the relationship at the firm level. More specifically, they find that compared with a dollar of traditional corporate R&D, a dollar of venture capital could be 10 times more effective in stimulating patenting. In this paper, they also realize that there is a causality issue between VC and patenting: the boom of patenting after receiving VC is not because of the stimulation role of VC on innovation, but because the motivation for firms to patent is to impress potential venture capitalists, or to avoid their innovations being copied by the venture capitalists. To disclose this relationship, they construct a sample of 122 venture-backed and 408 non-venture-backed companies in Middlesex County, Massachusetts and then compare the quality of patents between the two subgroups. The results indicate that the quality of the patents (measured by patent forward citations and patent litigations) in venture-backed companies is higher. Putting the results in another way, VC does have a positive impact in stimulating firms' innovation activities.

Bertoni, Croce and D' Adda (2010) also prove there is a positive relationship between VC funding and innovation. By considering a sample of 351 Italian new technology-based firms, they find VC funding spurs firms' subsequent patenting behavior. Using a sample of 233 VC-backed firms and 91,381 controls in Spain, Arque-Castells (2012) find VC funding spurs subsequent patenting according to an inverted U-shape trajectory. They argue that before full development of products, more inventions are likely to be generated; but once the products are fully developed, the number of inventions generated should decrease because the

focus would shift from development to sales.

However, in a study of young German firms, Engel and Keilbach find VC-backed firms display higher growth rates, but not innovative output, measured by patent applications. Similar results can be seen from an analysis of Austrian firms by Peneder (2010). Peneder (2010) first find that VC backed firms have better growth and innovation performance. Nevertheless, they further find that the higher innovation performance is because the firms selected by venture capitalists are more innovative than the others, not because VC funding causes firms more innovative. These two studies suggest that venture capitalists may assist their portfolio firms in commercialization, rather than further inventions (Engel & Keilbach, 2002). That is, the second contribution of VC funding on innovation calls attention.

Patent number, as is often used in the literature to measure innovation, captures the technological invention side of innovation. Since many patented inventions will never be converted into innovations and commercialized products, patents are considered only a reliable indicator for inventions, not for innovations (Millot, 2009). In contrast, trademark is more related with the commercialization side of innovation (Schmoch & Gauch, 2009). To complete the picture of the effect of VC funding on innovation, in Chapter 5 we will analyze VC's influence on startups' trademarking propensities.

2.4 Conclusions

About the criteria used by venture capitalists to evaluate startups, it can be seen that most

scholars focus their attention on management team, patenting and external alliances as important criteria used by venture capitalist in the literature. However, all these criteria are related with only one dimension of reputation: the attribute specific dimension of reputation. The investigation of the other two dimensions of reputation (generalized visibility and generalized favorability) on VC funding is rare in the literature. General reputation, as an important intangible asset, has many merits making it a good signal to indicate startups' underlying quality and future performance potential. For instance, thanks to the characteristic of hard imitation coming from its intangible nature and its accumulation from historical track, general reputation can be used as a means to construct sustainable competitiveness for startups, which is beneficial to bring more returns to venture capitalists. Thus, general reputation should influence the access to VC funding. This relationship will be studied in detail in Chapter 4.

As far as the effect of VC funding on innovation is considered, regardless of what level of analysis, most of the empirical studies have used patent data as a proxy for innovation. Nevertheless, innovation is a process leading from technological invention to commercialization of products in the market. In this sense, patents can only reflect the invention stage of innovation, but not the commercialization stage. Conversely, on the one hand, trademarks can be a partial indicator of invention, in the sense that usually the registration of new trademarks reflects the introduction of new products or services; on the other hand, they reflect the marketing capabilities of inventions (Jensen & Webster, 2011; Mendonça et al., 2004). Therefore, trademarks may be an alternative measure of innovation

and enable us to have an entire understanding of innovation.

In addition, as several researchers have pointed out (Mendonça et al., 2004; Millot, 2009), trademark data can be used as a good indicator empirically, because: first, trademarks have been recorded systematically for many years; second, the data is easy to get since all are in the electronic databases; third, huge number of trademarks are filed and it is good for statistical analysis; fourth, they are present in nearly all the sectors, including service sectors in which patents data is few; fifth, they are registered for one or several classes enabling researchers to do some comparisons among various sectors. Furthermore, they are supposed to be widely used by startups due to the reason that they are cheaper and take less time to be registered compared to patents, indicating that they are more capable of keeping pace with the market (Mendonça et al., 2004). Therefore, in this dissertation, we try to contribute to the literature by investigating the effect of VC funding on startups' trademarking activities. This will be studied in Chapter 5.

3 The context of the study: the micro and nanotechnology sector in the United Kingdom

This chapter gives an introduction of the context used to investigate the research questions in this dissertation, namely the micro and nanotechnology (MNT) sector in the United Kingdom. We begin by defining what micro and nanotechnology is and its key characteristics. Section 2 introduces the development of micro and nanotechnology in the United Kingdom. Section 3 presents funding situation associated with MNT firms and innovation issues related with MNT firms are introduced in section 4. Finally section 5 in this chapter gives conclusions on why the MNT sector in the United Kingdom is an interesting setting to investigate our research questions.

3.1 The micro and nanotechnology sector: key characteristics

There is not a universally accepted definition of what nanotechnology is. We thus adopt a broad definition of nanotechnology as "the design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/ superior characteristics or property"

(Bawa, Bawa, Maebius, Flynn, & Wei, 2005). It is a novel technological field, with the emergence in the 1980s. One key invention in this field is the invention of the scanning tunneling microscope in 1981 by Gerd Binnig and Heinrich Rohret at IBM Zurich Research Laboratory (Darby & Zucker, 2003). Then the discovery of fullerenes in 1985 makes a great contribution on the development of micro and nanotechnology. The commercial applications of nanotechnology began in the early 2000s. Also in the early 2000s it began to capture growing public awareness.

The micro and nanotechnology can be used to a wide range of sectors ranging from consumer products through medical products to plastics and coatings and electronics products (Nanoscience and nanotechnologies: opportunities and uncertainties, 2004; UK Nanotechnologies Strategy: small technologies, great opportunities, 2010). It has been developed rapidly in both the research area and the application area over the world (Aitken, Chaudhry, Boxall, & Hull, 2006). The number of nanotechnology products or product lines on the market was increased from 210 in 2006 to 800 in 2010. The revenue of nanotechnology-based products is expected to grow from $2.3 billion in 2007 to $81 billion by 2015 in the global market (UK Nanotechnologies Strategy, 2010). Meanwhile, nanotechnology has the potential to change our everyday life as information and communication technology (UK Nanotechnologies Strategy, 2010). Even though this technology has been commercially accessible, it is in novel uses and the use of it is associated with sufficient tacit knowledge (Darby & Zucker, 2003), making owners of the technology have the potential to earn above-normal profits. It is one of the emerging technologies but at a

very early stage of development.

In conclusion, micro and nanotechnology has experienced a pronounced development over the last years. It is a breakthrough discovery having the potential to drive technological process and change our future life. At the same time, the use of it is very imperfectly understood and is related with tacit knowledge. Therefore, few firms can successfully use them and the competition from imitators or sophisticated invent-arounders is not a serious problem, leading to high potential to earn above-normal returns (Linton & Walsh, 2004). Consequently, it is an attractive sector on venture capitalists.

3.2 Micro and nanotechnology in the United Kingdom

The micro and nanotechnology development in the UK is in an excellent position in the world. The number of nanotechnology companies in the UK is the third highest, after the US and Germany, and the number of nanotechnology patents in the UK is the fourth highest in the world, after the US, Japan, and Germany. The nanotechnology research in the UK is also well-known, with about 1,500 research scientists working on the development of nanotechnologies (UK Nanotechnologies Strategy: small technologies, great opportunities, 2010).

In the UK, the micro and nanotechnology companies are mainly related with the following sectors: coatings and inks, biotechnology, speciality chemicals, electronics, sensors, instrumentation, medical devices and drug delivery. The majority of them are small and

medium with respect to size (UK Nanotechnologies Strategy: small technologies, great opportunities, 2010). In terms of lifecycle in which a nanotechnology experiences: pioneers, startups, shake-out, mainstream, acquisition / mergers, consolidation, and obsolescence, nanotechnology is currently in a phase where majority of the active firms are starting up new ventures (Shah, 2004).

The excellent position of micro and nanotechnology in the UK is highly related with the UK government commitment on micro and nanotechnology. The government commitment includes both fund support (which will be discussed in the next section of this chapter) and strategy and policy support.

In June 2003, the UK government commissioned the Royal Society and the Royal Academy of Engineering to study developments in nanoscience and nanotechnologies and their impact. Consequently, in July 2004, the Royal Society and Royal Academy of Engineering jointly launched the report "Nanoscience and nanotechnologies: opportunities and uncertainties", in which they recommended the Office of Science and Technology commission as an independent group to review what actions had been taken in 2-5 years' time. In response to the report, the Council for Science and Technology carried out a two-year review of the commitments set out by Government and launched the report "Nanosciences and Nanotechnologies: A Review of Government's Progress on its Policy Commitments" in March 2007. In this report, it shows that the UK is losing its leading position and falling behind in its engagement with this fast developing field. The main reason was explained as a lack of Government activity or funding in research into toxicology, health and environmental

effects of nanomaterials, even though Government had made progress on many of its commitments.

Then in 2007, the UK government established the Technology Strategy Board, which then set up the Nanotechnology Knowledge Transfer Network (NanoKTN). The function of the NanoKTN is to promote and facilitate knowledge exchange, to support the growth of UK capabilities, to raise public awareness of nanotechnology, and to provide thought leadership and input to the UK policy and strategy. To achieve the goal, a series of actions have been taken. For example, it assisted the 23 UK MNT Capital facilities to develop capabilities and provide knowledge for those wishing to commercialize nanotechnology (Nanotechnology in the UK, 2008).

In 2009, the UK government launched a strategy for nanotechnologies: *UK Nanotechnologies Strategy: Small Technologies, Great Opportunities*. The mission of the strategy is to support innovation and promotion of the use of the emerging and enabling technologies in a safe, responsible and sustainable way, and finally enable the UK's economy and consumers to benefit from the development of nanotechnologies. In order to reach the goal, the UK government has identified several actions outlined under four categories: business, industry and innovation; environmental, health, and safety (EHS) research; regulation; and the wider world.

Firstly, the actions under the business, industry and innovation category mainly include establishing a Nanotechnologies Leadership Group, encouraging companies and academics to apply for funding through Grand Challenge calls from the Technology Strategy Board

(TSB) and research councils, and promoting national and international awareness of the UK nanotechnologies capability.

Secondly, the actions under the EHS research strategy mainly include exploring approaches to Environmental, Health and Safety (EHS) research on nanotechnologies by the Chief Scientific Adviser network, and government and publically funded research on many crucial EHS nanotechnologies issues such as the behavior of key nanomaterials in the gut when eaten and when inhaled into the lungs.

Thirdly, the actions under the regulation strategy mainly include expanding the scope of the work on a scheme to succeed the pilot voluntary reporting scheme to include products as well as materials, monitoring the success of implementation of upcoming amendments to novel foods and cosmetics directives with respect to nanomaterials, and making the Medicines and Healthcare Product Regulatory Agency (MHRA) and the Health and Safety Executive (HSE) perform horizon scanning and monitoring in order to detect necessity for amendments to legislation in the future.

Finally, the actions under the wider world strategy mainly include establishing the Nanotechnologies Collaboration Group to facilitate ongoing communication and collaboration between Government, academia, industry and other parties, and making information about Government's ongoing actions on nanotechnologies accessible to the public on a portal website.

As with other instances of metamorphic progress, nanotechnology is concentrated in a few countries and a few regions in those countries (Darby &Zucker, 2003). MNT startups are

concentrated in six clusters in the UK: Cambridge, London, Oxford, Durham, Edinburgh, and Manchester. Cambridge Technopole is the largest MNT cluster in the UK. The key technology sectors in Cambridge Technopole include information technology, mobile telecommunications, biotechnology, electronics, instrumentation, nanotechnology, and inkjet printing. According to some publications, such as Time, Fortune, and wired, Cambridge Technopole is one of the world's leading high technology business clusters (Shah, 2004).

In a word, the UK Government has realized the importance of nanotechnology and its potential on the future position of world economy. To support the development of nanotechnology, the UK government has made great commitments and the UK nanotechnology is in a good position in the world, especially in the Europe.

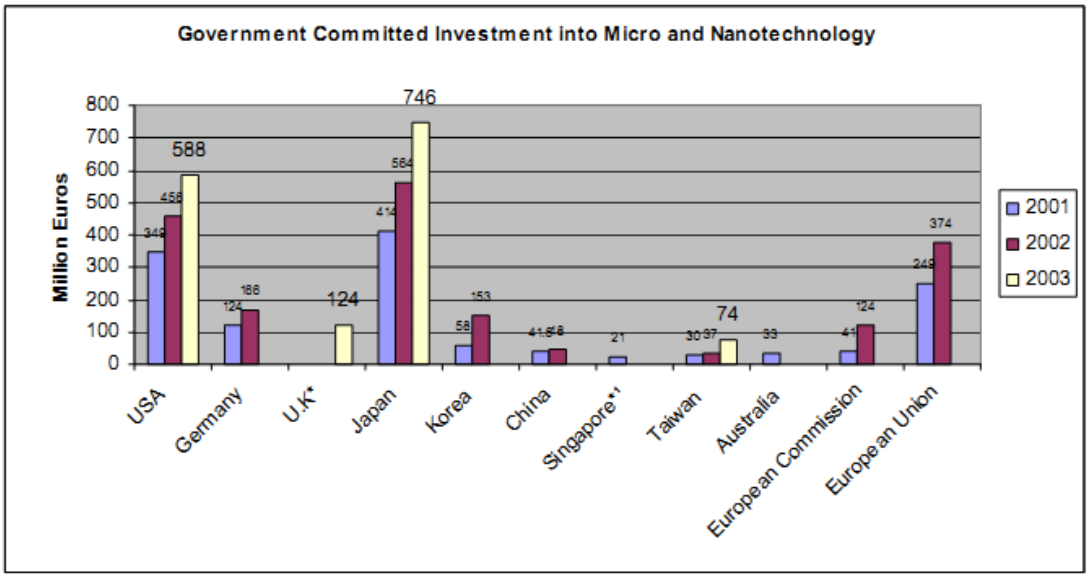
3.3 Micro and nanotechnology and funding

The funding invested in nanotechnology R&D in the developed world has accelerated rapidly. It was reported that the worldwide government spending had increased about seven-fold from $0.43 billion in 1997 to $3.0 billion in 2003. There were at least 35 countries had initiated R&D activities in nanosciences by 2003. Except for government funding, public and private funding on nanotechnology was estimated to amount to $4.0 billion in 2002. More than 100 venture capital groups invested $0.5 to $1.0 billion into nanotechnology R&D projects in 2002. Global authorities, especially in the USA, Japan and EU, have recognized the need to fund nanotechnology R& D to establish a leading position in nanotechnology and to finally

have a strong economic platform in the future (Waters, 2003).

In the UK, according to a report by the Department of Trade and Industry (DTI) in 2004, the government investment in micro and nanotechnology is in the second highest level in Europe, after Germany (Figure 1). In 2002, the DTI dedicated $48 million to nanotechnology on top of existing funding for subject-specific research councils (Waters, 2003). In July 2003, there was a cash injection of £90 million (124 million Euros) over a six period (2003-2008) by the Science and Innovation Minister Lord Sainsbury - £50 million for the applied research programme to support collaborative research and development projects and technology transfer initiatives, and £40 million for Capital Projects for a UK Micro and Nanotechnology Network (Munari & Toschi, 2011; Shah, 2004).

Figure 1 Worldwide government investments in MNT Sector



(Source: DTI Report 2004)

In 2002 and 2003, the UK government support for nanotechnology research in universities increased significantly, especially the new University Innovation Centre in microsystems and nanotechnology at the universities of Newcastle and Durham and Interdisciplinary Research Collaborations (IRCs) based on the universities of Oxford and Cambridge. The IRCs was funded $30.5 million (Waters, 2003).

Then from 2003 to 2008, Engineering and Physical Sciences Research Council (EPSRC) supported about £253 million for nanotechnology distributed over a portfolio of some 400 projects. The main recipients can be seen in Table 1. Consistent with the support in 2002 and 2003, the University of Oxford and the University of Cambridge received a high portion of the funding, following by University of Sheffield and Imperial College London.

Table 1 Principal academic funding from EPSRC for nanotechnology (2008 data)

Academic Institution	Research Funding	Academic Institution	Research Funding
University of Oxford	£37 million	University of Nottingham	£10 million
University of Cambridge	£27 million	University of Strathclyde	£9 million
University of Sheffield	£21 million	University of Glasgow	£8 million
Imperial College London	£19 million	University of Manchester	£8 million
University of Surrey	£11 million	University College London	£8 million
University of Birmingham	£10 million	University of Southampton	£7.5 million

(Source: Nanotechnology: a UK Industry View, 2010)

In total, from 1998 to 2010, an amount of approximately £642.60 million was supported for nanotechnology by the UK Government (Table 2). Table 2 also tells us an increase trend on nanotechnology support by the UK Government, reflecting its realization of the importance of nanotechnology and its commitment on promoting the development of nanotechnology.

Table 2 Estimated Government support for nanotechnology

Year	Estimated amount
2009/2010	£83.20 million
2008/2009	£77.60 million
2007/2008	£73.50 million
2006/2007	£66.27 million
2005/2006	£66.00 million
2004/2005	£65.76 million
2003/2004	£60.80 million
2002/2003	£40.58 million
2001/2002	£50.00 million
2000/2001	£35.50 million
1999/2000	£11.00 million
1998/1999	£12.39 million
Total	£742.60 million

(Source: Nanotechnology: a UK Industry View, 2010)

The investment by the venture capitalists on micro and nanotechnology startups was concentrated on certain startups in the UK. A similar trend is also present in the US. According to Lux Report in 2004, the top five nanotech startups funded by venture capitalists had raised 22% of total nanotech VC funding, about more than $246 million since 2001 (Shah, 2004).

Meanwhile, venture capitalists investing in MNT are also very concentrated. For example, there are about 9 venture capitalists in Cambridge that have funded MNT deals. In addition, many other venture capitalists have interests in MNT but have not made investments yet.

3.4 Micro and nanotechnology and innovation

"Nanotechnology has been a burgeoning area of science and engineering since at least 1990" (Darby &Zucker, 2003). The scientific and technological excellence of a technology can be seen from two indicators: publications and patents. There was on average one third articles per thousand on nanotechnology from 1981 to 1989, showing no difference from the mean of all science and engineering articles. Then since 1990, the nanotechnology articles have exceeded 2 percent of all science and engineering articles, exhibiting a remarkable growth. Except for the US, the nanotechnology articles were divided among the UK, Australia, France, Germany, Japan, and Switzerland (Darby &Zucker, 2003). In terms of patents, there were on average 33.3 patents granted per year during 1976 and 1986 (Darby &Zucker, 2003).

In the US, there were about 350 nano patents issued in 1998, while in 2001, three years later, the amount of nano patents issued increased to over 700 (Shah, 2004).

As far as the UK is concerned, there is a strong R&D support from universities and institutions for the nanotechnology industry in the UK (Aitken et al., 2006). There are about 55 non-commercial organizations undertaking nanotechnology-related R&D, including universities, spinoffs and private companies (Aitken et al., 2006). According to the Nanotechnology KTN database, there were over 60 academic groups engaged in nanotechnology in different levels in the UK in 2010. A SWOT analysis for the UK capability in nanotechnology shows that it has strong academic support, metrology and instrumentation expertise, and good track record of nanotechnology startups (Nanotechnology: a UK Industry View, 2010), indicating an excellent potential nanotechnology invention position and commercialization position of nanotechnology in the UK. However, the use of nanomaterials is not so developed in the UK with a few companies using nanoparticles in any significant quantities. Nevertheless, "this situation is likely to change rapidly" (Aitken et al., 2006).

3.5 Conclusions

MNT sector in the United Kingdom is an interesting context to study our research questions for several reasons. First, even though MNT is an emerging technology and is in its early stage of development, its commercial applications have been developed rapidly over the world. Moreover, few firms possess knowledge and capabilities to perfectly use it, making

them have the potential to earn above-normal returns (Linton & Walsh, 2004). Therefore, the MNT sector is an attracting sector for venture capitalists given that venture capitalists like to finance nascent high-technology based industries.

Second, the MNT growth in the UK is in an excellent position, characterized by the third highest number of nanotechnology firms, the fourth highest number of nanotechnology patents, the strong nanotechnology R&D support from universities and institutions (UK Nanotechnologies Strategies: small technologies, great opportunities, 2010), and the good track record of nanotechnology startups (Nanotechnology: a UK Industry View, 2010). Moreover, the MNT sector has received widely supports from the UK government including both financial support and policy support. Therefore, the MNT sector, especially in the case of the United Kingdom is an interesting context.

Third, this context has already been studied by other researchers, such as Linton and Walsh (2004), Munari and Toschi (2011), which can be an useful benchmark for our studies.

4 Does reputation facilitate the access to VC funding in startups?

This chapter is the first empirical study, analyzing the effect of different dimensions of startups' reputation along with their management team heterogeneity on the access to VC funding. It starts with an introduction section and then section 2 provides a theoretical background. Section 3 discusses our hypotheses. Section 4 introduces the research context, data and method, and empirical results are in section 5. Section 6 presents conclusions and directions for future research.

4.1 Introduction

As an important intangible asset, corporate reputation has received a lot of attention over the last years (Rindova, Williamson, & Petkova, 2010). Most of previous literature analyzing corporate reputation focused on established large firms; while the knowledge about reputation for startups is rather limited. Moreover, previous studies have primarily focused on the relationship between reputation and consumers (e.g., Caruana (1997) and Rindova et al. (2005), while the association between reputation and venture capitalists remains a relatively

unexplored topic (Hellmann & Puri, 2000).

Reputation is especially important in markets with incomplete information such as the financial markets for innovative startups. The suppliers of financial capital have limited information on the demand because of the uncertain market prospects of new technologies and limited track record of startups' performance. However, finance is a fundamental input for startups, especially for technology-based startups. Compared with other financial intermediaries venture capitalists are more efficient in dealing with the typical problems arising from information asymmetry (adverse selection and moral hazard) (Hellmann & Puri, 2000). Venture capitalists rely on various mechanisms to reduce information asymmetry such as screening, staged investment flows, involvement in the board of directors of the backed firms, and coaching. This chapter focuses in particular on signaling as a mechanism that reduces ex ante information asymmetry and adverse selection in early stage and seed capital financing. More precisely, we ask whether the startups' reputation affects the likelihood of receiving venture capital support beyond and above the effect of signals like patents and the composition of the management team that have been considered in the literature.

Reputation is "…characterized by a level of visibility with the organization, beliefs about what to expect from the organization in the future, and impressions about the organization's generalized appeal" (Lange et al. 2011). There are three dimensions of reputation that have been considered in the literature: generalized visibility, generalized favorability and attribute-specific favorability (Barnett et al., 2006; Caruana, 1997; Lange et al., 2011). Generalized visibility emphasizes the extent to which a startup is known by

stakeholders. Generalized favorability indicates the extent to which a startup is given favorable judgments by stakeholders (Lange et al., 2011). Attribute-related reputation is stakeholder-specific, because different stakeholder groups may put their attention on different attributes. However, in the empirical studies, "all but a handful of the studies draw on one unidimensional aspect of organizational reputation, namely, being known for something [attribute-specific reputation] … the dimensions of generalized favorability and being known [generalized visibility] both have interesting but greatly understudied implications for organizational outcomes" (Lange et al., 2011).

Moreover, different stakeholders may have different believes and opinions about the same organization which reflect their different social, economic and personal experiences (Gotsi & Wilson, 2001; Rindova et al., 2005; Zyglidopoulos, 2001). For example, investors care about different dimensions of reputation compared with consumers or at least assign different weights to the same aspect (Caruana, 1997; Helm, 2007). The investors' perspective is still not well known in the literature on firm reputation (Hellmann & Puri, 2000).

This chapter examines the role of reputation along with other types of signals that may affect the probability to receive venture capital such as the composition of the management team and startup's patents. Reputation is measured with two dimensions of media coverage, generalized visibility and generalized favorability. Early studies have investigated the signaling value of startups' characteristics such as scientific publications and patents. The characteristics of the management team are the most important investment criteria used by venture capitalists (Franke et al., 2008; MacMillan et al., 1985; Tyebjee & Bruno, 1984).

However, to the best of our knowledge, no early study has addressed the association between venture capital and the diversity of the venture-capital backed firm's management team. Management team heterogeneity could benefit team productivity by facilitating mutual learning or by providing collaborative skills (Hamilton, Nickerson, & Owan, 2003).

Our empirical analysis is based on an unbalanced panel data including 200 micro and nanotechnology startups founded from 1995 in the United Kingdom. The empirical results support the hypotheses that both the level of generalized visibility dimension and the level of generalized favorability dimension of reputation are positively and significantly associated with the access to VC funding. Moreover, management team heterogeneity has a positive effect on the likelihood of receiving VC funding.

Our findings provide a threefold contribution to the literature. First, as commented by Lange, Lee and Dai (2011), research about the outcomes of reputation is still in its infancy and we provide novel evidence about the effect of reputation on VC funding. Second, while only few earlier studies have measured reputation along more than one dimension (Lange et al., 2011), we measure different dimensions of reputation - generalized visibility measured by total media coverage and generalized favorability measured by the coefficient of favorableness. Third, we analyze the effect of team heterogeneity on VC funding. While extensive scholars have analyzed the effect of team heterogeneity on firm performance (see for instance, Bantel & Jackson, 1989; Laursen, Mahnke, &Vejrup-Hansen, 2004; Giuri, Ploner, Rullani, & Torrisi, 2010), no study has been done on the relationship between team heterogeneity and VC funding.

The remainder of the section is organized as follows. Section 2 gives a brief literate review on reputation and venture capital funding. We outline the hypotheses in section 3 and then empirical design and data are described in section 4. Section 5 presents the empirical results and the final section gives a conclusion and limitations of this study.

4.2 Background

Information asymmetry hinders startups from receiving financing (Audretsch, Bonte, & Mahagaonkar, 2009; Carpenter & Petersen, 2002; Leland & Pyle, 1977). This in turn may result in adverse selection, i.e. exclusion of good quality entrepreneurship projects from the financial market. In these conditions, patents, trademarks, customers and licensing portfolios and certifications assets are reputational signals that reduce uncertainty and moderate the adverse selection problem (Akerlof, 1970). Favorable reputation is often positively associated with past performance. For instance, Deephouse and Carter (2005) find that returns on assets affect the favorable media reputation using a sample of US commercial banks. On the other hand, Standifird (2001) find that supplier's reputation is an important factor determining the final bid price in eBay auctions. More generally, a favorable reputation can be beneficial for future superior profit outcomes over time (Roberts & Dowling, 2002). Therefore, there is a bidirectional link between reputation and performance.

For our purposes here, a signal is any indicator of capability that can be manipulated by the actor and the signaling costs are inversely correlated with the actor's level of capability

(Spence, 1973). Reputation is a signal that a firm can produce through activities such as advertising and a better product quality.

Many signals that are used by venture capitalists as evaluation criteria have been studied in the literature. For example, on a general level, signals have been studied in the literature include market attractiveness, product differentiation, managerial capabilities (management team), environmental threat resistance, and cash-out potential (MacMillan et al., 1985; Muzyka et al., 1996; Petty & Gruber, 2011; Tyebjee & Bruno, 1984). At a more specific level, signals include experience, university degree, age, mutual acquaintance of the management team (Franke et al., 2008), similarity between firms' management team and venture capitalists in terms of training and professional experience (Franke, Gruber, Harhoff, & Henkel, 2006), patenting (Baum & Silverman, 2004; Cao & Hsu, 2011; Haeussler et al., 2008), firms' external alliances (Baum & Silverman, 2004; Hoenig & Henkel, 2012), and private equity placements (Janney & Folta, 2003). The management team experience can be further differentiated into team industry experience, prior job experience, leadership experience (Franke et al., 2008; Meyerinck et al., 2012), and prior founding experience (financially successful vs. unsuccessful experience) (Hsu, 2007).

Even though there have been no studies investigating the influence of media coverage in the selection process of VC funding, there are at least two reasons to believe media coverage have important effect on VC funding: first, as a first, simple explanation, the media act as mirrors of reality reflecting startups' behaviors and performance that may reducing the information asymmetries between startups and venture capitalists; second, they also

influence or shape public opinions, beliefs, and attitudes toward startups (Fombrun & Shanley, 1990; Deephouse, 2000) and finally affect startups' market competition (Ferrier, 1997). Given that venture capitalists are one group of the public, the media are also likely to influence their attitudes toward startups and finally influence their evaluation of startups.

In addition, each of those signals have been studied in the literature can be categorized as attribute-specific reputational signals in that they can lead an organization to 'being known for something' such as better product quality and market success that are relevant to its particular groups of stakeholders (Caruana, 1997; Lange et al., 2011). This dimension of reputation has received a great empirical attention because it is relatively simple to assess a particular organizational attribute or characteristic and associate specific attributes with performance indicators (Lange et al., 2011). The literature on organizational reputation has distinguished attributes-specific reputation from general visibility or prominence (being known) (Saxton, 1998) and generalized favorability (Gotsi & Wilson, 2001). These two dimensions of reputation are not associated with specific organizational characteristics; but instead they account for the generalized assessment of the organization which could arise from the combination of various attribute, experience and past performance. To our knowledge, previous studies have not considered these dimensions of reputation in the finance of startups. Attribute-specific dimension of reputation enables venture capitalists to have deeper insights on startups' specific attributes; while generalized visibility and generalized favorability dimensions of reputation enable them to understand the generalized potential of a startup. Our analysis tries to study the effect of the two general dimensions of

reputation. In line with Lange et al (2011), we believe that investigation of organizational reputation as a multidimensional phenomenon can improve our understanding of startup funding.

4.3 Hypotheses

4.3.1 Generalized visibility

Sequential investment decision steps are organized by venture capitalists, such as deal origination, screening process, evaluation step, structure the deal and post-investment activities (Tyebjee & Bruno, 1984). Normally there is a large excess demand for venture capital funding which gives rise to a tough selection of proposals. About 80% of all proposals submitted to a VC firm are rejected in the initial stage of the evaluation process (Franke, Gruber, Harhoff & Henkel, 2008). Therefore, it is critical for startups to catch venture capitalists' first attention. A firm's media visibility reflects generalized awareness or prominence of the firm in the collective opinion (Carroll, 2004; Carroll & McCombx, 2003). Therefore, a higher level of media visibility makes startups more likely to capture the attention of venture capitalists.

A higher level of media visibility also facilitates the access to startup information, and consequently reduces the level of uncertainty about the firm's potential value (Baker, Powell, & Weaver, 1998; Capriotti, 2009). By contrast, a limited media visibility increases investors'

monitoring costs, since firms with limited visibility are less exposed to the scrutiny of stakeholders. Therefore, visibility benefits venture capitalists by reducing their monitoring costs (Baker et al., 1998).

Usually "stakeholders have limited capabilities to process information so they pick and choose media exposure (ME) data using combinations of automatic and 'effortful' processes" (Wartick, 1992: 35). Although in the long run venture capitalists can rely on frequent contacts to have a better understanding about a startup, media visibility makes venture capitalists to have a quick impression on a startup in the short run. Media visibility then reduce initial informational barriers by providing venture capitalists with useful information about the firm's products or financial performance: "the newspapers present the companies to the public mainly as economic actors, as they give a lot more visibility to the companies' economic-financial issues and activities than their social issues and actions" (Capriotti, 2009: 239). Therefore, we expect that the level of visibility is positively associated with the startup's possibility to receive VC funding.

H1: The level of a generalized visibility is positively associated with the likelihood of receiving venture capital funding.

4.3.2 Generalized favorability

Generalized favorability is another dimension of reputation. Compared with generalized

visibility, this dimension of reputation is based on the incidence of favorable news and therefore it offers a venture capitalist finer-grained information about a startup's quality.

A generalized favorability is difficult for competitors to replicate and thus it represents a barrier to imitation. Reputation is rooted in a firms' history and unfolds over time through its products, services and strategy. Moreover, reputation builds upon interactions between a firm and its stakeholders and therefore it is the result of a combination of internal and external factors. The complexity of factors leading to favorable reputation gives rise to causal ambiguity and protects the firm's competitive advantage and future profitability from the threat of imitation. In addition, reputation is not tradable (Deephouse, 2000) and this contributes to the strategic value of this asset (Dierickx & Cool, 1989).

A favorable reputation affects the startup's performance and competitive advantage by facilitating access to other resources, such as talented people and other key inputs (Fombrun & Shanley, 1990). Talented people prefer to work in firms with a favorable reputation and sometimes they can trade off wages with the benefits of working in a firm that enjoys generalized favorability. These choices can be driven by intangible benefits such as prestige or status and more tangible benefits such as expected future wages and job security offered by a firm that is assessed favorably by stakeholders. In turn, talented people contribute to improve the firm's capabilities and profitability. For example, a study on eBay auctions shows that reputation is positively correlated with the price a seller could command (Stephen, 2001). Reputation then affects potential performance by providing protection from imitation and attracting strategic resources. Realized performance in turn affects future reputation and

gives rise to a classical circle "favorable get more favorable and unfavorable get more unfavorable" (Boyd et al., 2010).

From the discussion above it is clear that in a market where it is difficult to distinguish good entrepreneurial projects from 'lemons', generalized favorable reputation provides a signal that venture capitalists can use before transaction to reduce uncertainty (Akerlof, 1970; Spence, 1973).

H2: Generalized favorability is positively associated with the likelihood of receiving venture capital funding.

4.3.3 Management team heterogeneity

Besides reputation, measured by the attention that media pay to a startup, venture capitalists rely on other signals of quality and potential value such as patents and team composition.

Venture capitalists rely on different criteria to evaluate start-ups ((Franke et al., 2008). Muzyka, Birley&Leleux (1996) identify thirty-five criteria used by venture capitalists in making investment decisions and find that the management team is the most important factor. The quality of the entrepreneur, proxied by experience and personality traits (such as capability of sustained intense effort, ability of evaluating and reacting to risk well, and so on), is also emphasized by MacMillan(1985). "There is no question that irrespective of the horse (product), horse race (market), or odds (financial criteria), it is the jockey (entrepreneur) who

fundamentally determines whether the venture capitalist will place a bet at all" (MacMillan et al., 1985). Similar results are also reported by Tyebjee and Bruno (1984), who find that managerial capability of entrepreneurs is a fundamental dimension that venture capitalists look at to evaluate potential deals.

To our knowledge the literature on venture capital has not considered so far the composition of the management team, especially its heterogeneity. Team composition is a signal that may affect the supply of venture capital both directly (venture capitalists take their decision by observing the team composition) or indirectly (through the effect of team member composition on reputation). We do not consider this latter effect but treats only the direct effect of team composition on venture capital.

Team composition has been explored in the literature, which has examined in particular the association between team heterogeneity and innovation. Heterogeneity among team members reduces groupthink problems arising from the search for conformity, inward-looking attitude and lack of exploration (Turner & Pratkanis, 1998). Team heterogeneity may also favor mutual learning (Hamilton et al., 2003). Moreover, diversified capabilities are difficult for competitors to learn and imitate (Bantel & Jackson, 1989; Galunic & Rodan, 1998). Therefore, a team with diversified characteristics is more attractive for the suppliers of financial resources (Bhide, 2000).

Since the future performance of startups is one of the most important factor influencing venture capitalists' investment decisions, likely venture capitalists will be concerned about the heterogeneity of the startup's management team.

H3: Management team heterogeneity is positively associated with the likelihood of receiving venture capital funding.

4.4 Research context, data and variables

4.4.1 Research context: startups in the micro and nanotechnology sector in the UK

We choose startups founded from 1995 operated in the micro and nanotechnology (MNT) sector in the United Kingdom to analyze the effect of reputation on the access to VC funding.

First, investments made by venture capitalists are mainly focused on early-stage firms and high-technology based industries (Gompers, 1995). Moreover, venture capitalists prefer to invest in nascent technology industries rather than mature technology industries, since nascent technologies are more likely to represent the future of a market (Tyebjee & Bruno, 1984). Micro and nanotechnology is a breakthrough discovery which may change our everyday life in the future as information and communication technology (UK Nanotechnologies Strategy, 2010). In addition, the use of micro and nanotechnology is not perfectly understood and the use of it is associated with tacit knowledge. Consequently, few firms have the capability to use them successfully and those few firms have fewer probabilities to confront serious competition from imitators, making the potential to earn above-normal returns greater (Linton & Walsh, 2004).

Second, due to their young age and limited resources to devote to building reputation, startups are less likely to achieve favorable reputation compared to established large firms. The effect of reputation for startups then is more valuable and its effect on VC funding is more interesting. Startups in micro and nanotechnology sector are especially interesting. Micro and nanotechnology has experienced a rapid growth in the research area over the world (Aitken et al., 2006). For instance, Linton and Walsh (2004) and Munari and Toschi (2011) have studied micro and nanotechnology sector. In the real world, nanotechnology related products and the revenues from nanotechnology-based products have been increased dramatically in the global market (UK Nanotechnologies strategy, 2010). The micro and nanotechnology is extremely important for the UK economy since the UK firms operated in nanotechnology area engage in each stage of the supply chain (Nanotechnology: a UK Industry View, 2010). Moreover, the number of nanotechnology related firms in the UK is the third highest, after the US and Germany. The UK has a good position in the micro and nanotechnology development (UK Nanotechnologies Strategy: small technologies, great opportunities, 2010).

4.4.2 Data collection

We use a hand-collected panel data in this chapter. First, according to the Industrial Map of UK MNT, in total, there were 372 companies operating in the MNT sector in the UK by 2004, among which an initial sample of 201 startups was identified. The industrial Map of UK

MNT was collected by the MNT Network and the Department of Trade and Industry in 2004. Startup basic information, including founding year, region, and corporate origin, are contained in the Industrial Map of UK MNT.

Second, Companies House was used to check for name changes and status for the startups. Company name was used to obtain startups' other information. We obtained all the names a company used in history.

Third, the VC funding information was gathered through Thomson One (formerly, VentureXpert). Except for VC funding information, we identified additional 9 VC-funded startups operating in the MNT sector from Thomson One.

Fourth, media coverage was collected from LexisNexis Academic. Following the procedure adopted by Deephouse (2000) in measuring the media reputation, we first identified news in terms of favorable, unfavorable, and neutral. If there was more than one startup in an article, we coded them independently. By favorable, it means a startup is praised for its actions or involved in some events that may increase its reputation, for example, receiving award for their technologies. An unfavorable recording occurs when a startup is criticized for its actions or involved in some events that may decrease its reputation, like disappointing market competition of a technology, and then the startup was commented as "...enables researchers to do what was impossible before". A neutral rating is coded when a startup is reported without any evaluations. Virtually, there are favorable, unfavorable and neutral news for each startup.

Fifth, director information was collected by the following steps. Director list for each

startup was found from FAME. 10 startups could not be found from FAME. Since director heterogeneity is an important independent variable in this article, we excluded these 10 startups from our sample. Information about directors in FAME includes current and previous list of directors with title, appointment date, resignation date and birthday for each director. Company Director Check was then used to collect information on each director's previous occupational experience background. Finally, directors' publication information was collected from Scopus.

Finally, European patent applications and their forward citations for each company were collected from QPAT. Here, we decided to use patent application date, rather than grant date as the relevant date, because the application date has already reflected startups' possess of innovations.

In short, the final sample includes 200 startups founded from 1995, including 69 VC-funded and 131 non VC-funded startups. The final dataset is structured as an unbalanced panel data over the period from each startup's founding year until December 31, 2010.

4.4.3 Variables

(1) Measuring reputation

There are two approaches in the literature to measure reputation: a direct approach and an indirect approach. A direct approach is to measure reputation itself through direct interviews

with key stakeholders. An indirect approach is to infer reputation from the perception or assessment of observable firm attributes or third-party actions (Rindova et al., 2005). Most researchers have used indirect approach to measure reputation, such as Fortune magazine's corporate reputation index and media coverage.

Fortune magazine's Corporate Reputation Index is a widely used method to measure reputation (Bauer, 2010), which was used by more than one fifth of the 16 studies on reputation Lange et al. reviewed (Lange et al., 2011). The index is achieved by asking thousands of senior executive, outside directors, and financial analysts to rank the top 10 companies in their industry based on 8 criteria (Highhouse, Broadfoot, Yugo, & Devendorf, 2009a). However, this measurement can just apply to large firms, and is mostly linked with firms' previous financial performance, rarely about other aspects (Bauer, 2010; Brown & Perry, 1994a; Fryxell & Wang, 1994; Lange et al., 2011). Another criticism is that consumers, employees and other important stakeholders are not covered by the survey (Fryxell & Wang, 1994).

In addition to Fortune Magazine's "Most Admired Corporations", there are also some other rankings, such as "Asia's Most Admired Companies" by Asia Business Magazine, "Review 200" by Far Eastern Economic Review, "Britain's Most Admired Companies" by Management Today, "Europe's Most Respected Companies" by Financial Times, and so on (Fombrun, 1998).

Instead of using publication rankings, Deephouse (2000) adopts media reputation to depict organizational reputation. Rindova et al. (2007) also demonstrate that media coverage

could depict initial reputation accumulation process, since on the one hand, media, as a public agent, form their own opinions unobtrusively; on the other hand, as an influential audience, they influence others' opinions and perceptions. Fombrun and Shanley (1990) point out that firms with more positive news coverage are more likely to be in the list of Fortune Magazine's Most Admired Corporations. Further, the amount, tone and recency of media coverage significantly influence the change of corporate reputation in Fortune's Most Admired Corporations (Wartick, 1992). Previous articles have used media coverage most for established large firms, although some of them have referred also to startups. We will be one of the few to use it for startups.

To our knowledge, the study by Rindova et al. (2005) is one of the few to measure reputation directly. The authors differentiate business school reputations into two dimensions: perceived quality and prominence. Then they measure these two dimensions directly. As for prominence, it is measured by the number of recruiters that nominated a given school. The average of recruiters' ratings of a school is used to measure perceived quality.

Even though the direct approach can directly reflect venture capitalists' impressions and opinions toward a startup, given that it is difficult to ask venture capitalists to evaluate each firm over time we prefer to measure reputation indirectly as done by most scholars. For panel data, the direct approach is indeed based on a very strong or even practically impossible assumption that venture capitalists remember very well about each firm's previous performance in each year. As for the indirect way, we choose media coverage as done by other articles on startups to measure the generalized dimension of reputation, because on the

one hand, Fortune Magazine's reputation index is only about large firms; on the other hand, media coverage enables us to measure both the generalized visibility dimension (the total amount of media coverage a firm received) and the generalized favorability dimension (the coefficient of favorableness based on the favorable, neutral and unfavorable news a startup received) of reputation. In addition, media coverage has some advantages in terms of reputation reflection. First, media selects a firm to report from a huge number of firms, which makes media coverage an important potential signal of firms' underling quality. Second, as a public agent, the media form their opinions more objectively. Third, it avoids the main problem of the use of Fortune Magazine reputation index, namely, the financial halo effect.

(2) Variables

To explore the effect of reputation on the likelihood of receiving VC funding, the dependent variable involved here is a dummy variable, $dumvc_{it}$ which takes value 1 if startup *i* received VC funds in a given year and 0 otherwise.

There are three independent variables involved in this paper. First, *news* is used to measure the level of generalized visibility dimension of reputation. *News* is the number of media coverage the focal startup received in a given year.

Second, we use the coefficient of media favorableness as a proxy for generalized favorability dimension of reputation (Source: Deephouse (2000). The *coefficient of favorableness* is calculated as follows:

$$\text{Coefficient of media favorableness} = \begin{cases} (f^2 - fu)/(total)^2 \text{ if } f > u; \\ 0 \text{ if } f = u; \\ (fu - u^2)/(total)^2 \text{ if } u > f; \end{cases}$$

where "f" is the number of favorable news; "u" is the number of unfavorable news; "total" is the number of total news. The coefficient of media favorableness ranges from "-1" to "1", with "-1" implying all unfavorable reputation and "1" all favorable reputation.

Third, management team heterogeneity is concentrated on management team occupational background heterogeneity. Directors' occupational backgrounds reflect their professional orientation (Hambrick et al., 1996). A management team with diversified occupational backgrounds has the advantage to have comprehensive identifications and perceptions of startup problems, and can provide diverse solutions to these problems (Anderson, Reeb, Upadhyay, & Zhao, 2009). Increasing occupational background diversity allows for better division of labor, exploitation of complementarities and cross-fertilization, which are good for creativity and productivity. Our measure of heterogeneity is based on the Herfindahl-Hirschman index:

$$\text{heterogeneity} = 1 - \Sigma p_i^2$$

where p is the proportion of team members in each of the categories, and i is the number of different categories. The range of this variable is from 0 to (1-1/i). "0" means a totally homogeneous team. The closer the value is to (1-1/i), the more heterogeneous the team is. To calculate occupational experience heterogeneity, six groups of occupational background are first identified: accounting, general management, law, engineering, finance, and others. The

Herfindal-Hirschman index is then used to calculate the occupational experience heterogeneity.

Finally, we also include some control variables which may affect the access to VC funding:

Other management team characteristics- Team scientific capability is important for further upgrading of technologies and transferring basic technology into practical technology. It is expected there is a positive association between management team scientific capability and VC funding. *Meandoctor* and *totalpublication* are used to measure director's scientific capability. Meandoctor is calculated by the number of directors with a PhD degree divided by the total number of directors. Some directors are professors, but there is no information about whether they have a PhD degree or not. However, professors are supposed to have a PhD degree in the UK. We thus assume all professors have doctor degree. *Totalpublication* is the total amount of publications on all the directors for a startup in a given year.

Innovation characteristics- venture capitalists like to finance start-ups with strong technologies (Baum & Silverman, 2004). Technology based startups with radical technologies have a greater opportunity to survive (O'Shea, Chugh, & Allen, 2008). Patents are often used as a signal reflecting technology quality of a start-up so as to improve the chances of obtaining venture capital (Conti, Thursby, & Rothaermel, 2011). Hence, patent behavior, measured by a dummy variable *dumpatent*, is expected to positively influence the access to VC funding. Patent forward citations are often used to measure patent quality. Forward citations are citations about a patent made by other patents (Duguet & MacGarvie,

2005). Forward citations of a patent suggest recognition of its importance (Lanjouw & Schankerman, 2004). The variable *averagecitation* is also included in this section. It is the average patent forward citations for the focal startup in a given year.

Startup type- *Dumaso* is a dummy variable with value 1 if a startup is an academic spinoff. Previous literature tells us that entrepreneurs of academic spinoffs are historically in academic environment, not in business environment, which may make them more difficult to attract VC funding. On the other hand, strong scientific skills by academic spinoff entrepreneurs extensively increase the possibility to have high quality technology, which is a critical factor considered by venture capitalists.

Startup age- startup age is a startup's age since its founding year.

Region dummy- 12 region dummies are used to control for the region effect on the access to VC funding. Northern Ireland is the base.

All these variables are summarized in Table 3.

Table 3 Definition of variables

Variable type	Name	definition	source
Dependent Variable	$Dumvc_{it}$	Dummy variable taking the value of 1 for startup *i* received VC funding at year t	Thomson One
Independent variables	news	The number of news received by the focal startup at year t	LexisNexis
	Coefficient of favorableness	$$\text{coefficient of favorablenes} = \begin{cases} \dfrac{f^2 - fu}{(total)^2} & \text{if } f > u \\ 0 & \text{if } f = u \\ \dfrac{fu - u^2}{(total)^2} & if\ u > f \end{cases}$$ where "f" is the number of favorable news; "u" is the number of unfavorable news; and "total" is the number of news at year t.	LexisNexis
	Background heterogeneity	Group directors into six groups according to their occupational background: accounting, general management, law, engineering, finance, and others. The Herfindal-Hirschman index is then used to calculate background heterogeneity.	FAME; Company Director Check
Control variables	meandoctor	The number of directors with PhD degree divided by the total number of directors	FAME
	Total publications	Total number of publications on all the directors for the focal startup in a given year	Scopus
	Dum patent	Dummy with value 1 if the focal startup has at least one patent	QPAT
	Average citations	The total amount of forward citations received divided by the patent application stock	QPAT
	Startup age	Startup age at year t	MNT
	dumaso	Dummy with value 1 if the focal startup is an academic spinoff	MNT
	Region dummies	A set of 12 region dummies	MNT

4.5 Results

4.5.1 Descriptive analysis

Overall, 141 out of 200 (70.5%) startups have been reported at least once in the media. Among those VC backed startups, 89.96% (60 out of 69) startups have been reported at least once; while among those non VC backed startups, 61.83% (81 out of 131) startups have been reported in the media. Meanwhile, the p-value of the chi-square test is 0, indicating whether a startup is reported by the media is highly correlated with the likelihood of receiving VC funding.

When considering the sequence of media coverage and first round VC funding, there are 116 had media coverage first before receiving their first round VC funds; there are 20 received their first VC funds first before having media coverage; and there are 11 received their first VC funds and media coverage at the same year. For those 69 VC-backed firms, 35 reported by the media before receiving their first VC funds; 23 received their first VC funds before media coverage; and 11 received their first VC funds and were firstly reported by the media at the same year. These data tell us media coverage maybe has a positive influence on VC funding.

Table 4 presents the descriptive statistics for the main variables. It clearly shows that on average, each year VC funded startups have higher number of media coverage, higher coefficient of favorableness, and higher team occupational background heterogeneity than non VC funded startups (1.6 vs. 0.72, 0.15 vs. 0.09, and 0.4 vs. 0.32 respectively). Moreover,

the T-test p values also indicate that the average values about the number of news, the coefficient of favorableness and the team occupational background heterogeneity are all statistically different between the two groups: VC funded startups and non VC funded startups. The descriptive analyses results also show that the mean value of the coefficient of favorableness is positive for both the two groups, indicating favorable news dominate unfavorable news in the media regarding technology based startups.

VC funded startups are also related with higher likelihood of patenting and have higher average patent forward citations than non VC funded startups, indicating startups with great innovations have higher possibility to receive VC funding. Moreover, directors in VC funded startups have more scientific publications as compared to directors in non VC funded startups. However, the differences between the two groups are not so significant with respect to meandoctor. Both the two groups, on average, have 0.3 directors having doctor degree. One explanation is micro and nanotechnology has not been understood quite well in the application area and there is some tacit knowledge related with the technology applications (Linton & Walsh, 2004). Therefore, there should be some directors having a good knowledge on micro and nanotechnology for each startup. In addition, academic spinoffs are more likely to receive VC funding than non academic spinoffs.

These are only the preliminary descriptive results. We are going to do further regression analysis to have a better knowledge on the relationship between these variables in the following parts.

Table 4 Descriptive statistics

	VC Funded startups					Non VC Funded Startups					T-test p value
Variables	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**	
News	749	1.6	5.76	0	91	1424	0.72	1.99	0	26	0.000
Coefficient of favorableness	749	0.15	0.37	-1	1	1424	0.09	0.31	-1	1	0.001
Background heterogeneity	720	0.4	0.22	0	0.8	1366	0.32	0.24	0	0.75	0.000
Dum patent	749	0.58	0.49	0	1	1424	0.24	0.43	0	1	0.000
Average citations	749	0.18	0.67	0	8	1424	0.06	0.32	0	3.33	0.000
meandoctor	720	0.31	0.26	0	1	1366	0.3	0.29	0	1	0.595
Total publications	720	44.43	99.55	0	774	1366	18.13	48.17	0	347	0.000
dumaso	749	0.62	0.48	0	1	1424	0.46	0.49	0	1	0.000
Startup age	749	5.22	3.57	0	15	1424	5.18	3.54	0	15	0.79

4.5.2 Regression analyses

Table 5 reports the correlation matrix on the main variables. The largest correlation among our variables is 0.22, which indicates that multicollinearity is not a serious problem in our case.

Table 5 Correlation matrix

		1	2	3	4	5	6	7	8	9	10
1	dumvcit	1									
2	Number of articles	0.13***	1								
3	Coefficient of favorableness	0.15****	0.22***	1							
4	Background heterogeneity	0.09***	0.01	-0.004	1						
5	Dummy patent	0.18***	0.07***	0.09***	0.08***	1					
6	Average citations	0.01	-0.01	-0.004	0.04*	0.29***	1				
7	Meandoctor	0.03	0.03*	0.04*	0.05**	0.06***	-0.09***	1			
8	Total publications	0.17***	0.14***	0.04**	0.1***	0.11***	-0.002	0.08***	1		
9	Dumaso	0.06***	0.07***	0.06***	0.08***	0.08***	0.0002	0.24***	0.12***	1	
10	Startup age	-0.1***	-0.02	-0.07*	-0.05*	0.21***	0.08***	-0.02	0.06***	-0.02	1

Note: ***, **, and * denote significance level at 1%, 5%, and 10% respectively.

The dependent variable in our analysis is a binary variable: the likelihood of receiving VC funding. Given the nature of the binary dependent variable, logit or probit model can be used in our case. We first use skprobit to perform a Lagrange Multiplier test for the

normality of the residuals of a probit model to see whether probit model is appropriate in our case. The results show that the normality hypothesis is not rejected in our case. Therefore probit model is more appropriate. Even though Hausman test is usually used to choose between random or fixed effect model for panel data, since probit model is more appropriate in our case and there is no probit model with fixed effect, we could only resort to probit model with random effect in our situation.

Table 6 presents the results on the likelihood of receiving VC funding using Probit model with random effect. We start with a regression including only controls (model 1) and then we add the three independent variables one by one (model 2, model 3 and model 4). The coefficients on each of the three independent variables (*news*, *coefficient of favorableness*, and *background heterogeneity*) in all the models are significant and positive, giving support for all the hypotheses (H1, H2, and H3). Meanwhile, the coefficient on the "*coefficient of favorableness*" is larger than the coefficient of the "*news*", indicating except for the number of articles, venture capitalists concern about more on the tone of articles and favorable news has more impacts on VC funding. Consistent with previous studies, we also provide support on the importance of patent behavior on VC funding. Except for management team occupational background heterogeneity, their scientific capabilities, measured by "*total publications*", also have positive and significant influence on the likelihood of receiving VC funding. However, startup age is negatively related with the likelihood of receiving VC funding, suggesting that venture capitalists prefer to invest in early-stage development of startups.

Table 6 Regression results on the likelihood of receiving VC funding using Probit model with random effect

	Model 1	Model 2	Model 3	Model 4
Model	Probit RE	Probit RE	Probit RE	Probit RE
News		0.04***(-0.01)	0.03***(-0.01)	0.03***(-0.01)
Coefficient of favorableness			0.73***(-0.14)	0.73***(-0.14)
Age heterogeneity				0.53*(-0.28)
Dummy patent	0.84***(-0.14)	0.85***(-0.15)	0.82***(-0.14)	0.8***(-0.14)
Average citations	-0.21(-0.16)	-0.21(-0.17)	-0.24(-0.17)	-0.24(-0.17)
Meandoctor	-0.07(-0.24)	-0.1(-0.24)	-0.15(-0.24)	-0.15(-0.24)
Total publications	0.003***(-0.001)	0.002***(-0.001)	0.002***(-0.001)	0.002***(-0.001)
Dumaso	0.27(-0.17)	0.23(-0.18)	0.25(-0.17)	0.23(-0.18)
Startup age	-0.12***(-0.02)	-0.12***(-0.02)	-0.12***(-0.02)	-0.12***(-0.02)
Region dummies	YES	YES	YES	YES
Constant	-1.77***(-0.41)	-1.82***(-0.42)	-2.1***(-0.41)	-2.29***(-0.43)
Observations	2086	2086	2086	2086
Num. of groups	197	197	197	197
Log Likelihood	-493.36	-486.84	-473.17	-471.37
Prob > chi2	0	0	0	0
Lagrange Multiplier test p value	0.56	0.69	0.93	0.67

Note: *, ** or *** denote the coefficient is significant at 10%, 5% or 1% respectively. Standard errors are in parentheses.

4.5.3 Robustness check

First, except for occupational background heterogeneity among team members, we also try to understand another team heterogeneity variable, age heterogeneity, to see how the results change. In the literature, the study on the influence of team heterogeneity is focused on firm performance. Age is related with a person's attitude, value and perspective since different age cohorts experience different social, political, and economic environments (Bantel and Jackson, 1989). Different attitudes, values, and perspectives may facilitate creativity, which is beneficial for innovation (Bantel and Jackson, 1989). The empirical effect of management team age heterogeneity on firm performance is not in an unique direction. Anderson et al. (2009) find a positive relationship between age heterogeneity and firm performance using the Russell 1000 industrial firms for 2003 and 2005. In contrast, Simons et al. (1999) find a negative influence of age heterogeneity on firm performance. To provide more insights on this issue, we are going to investigate the effect of age heterogeneity on VC funding.

To know how heterogeneous a team is in terms of age, we first group directors according to their age: age between 21 and 30, age between 31 and 40, age between 41 and 50, age between 51 and 60, and age more than 60[1]. Then age heterogeneity is calculated with the Herfindal-Hirschman index.

Consistent with the procedure in dealing with occupational background heterogeneity, we first resort to a Lagrange Multiplier test to choose between probit and logit model. The results

[1]The directors' age varies between 21 years old and 86 years old.

indicate residuals are normal and probit model is more appropriate in our case compared with logit model. Therefore, same to the situation when considering background heterogeneity, we choose probit model with random effect to do the regressions. We start with a model including only controls and then add independent invariables one by one. Table 7 presents the results using probit model with random effect specification. Similar to the results when considering occupational background heterogeneity, the coefficients on each of the three independent variables (*news*, *coefficient of favorableness*, and *age heterogeneity*) are positive and significant, and the effect of the *coefficient of favorableness* is larger than that of *news* on the likelihood of receiving VC funding.

Table 7 Regression results on the likelihood of receiving VC funding using random effect model (age heterogeneity case)

	Model 1	Model 2	Model 3	Model 4
Model	Probit RE	Probit RE	Probit RE	Probit RE
News		0.04***(0.01)	0.03***(0.01)	0.03***(0.01)
Coefficient of favorableness			0.75***(0.14)	0.74***(0.14)
Age heterogeneity				0.92***(0.26)
Dummy patent	0.84***(0.15)	0.84***(0.15)	0.82***(0.15)	0.76***(0.15)
Average citations	-0.22(0.16)	-0.22(0.17)	-0.25(0.17)	-0.27(0.19)
Meandoctor	-0.14(0.24)	-0.18(0.25)	-0.23(0.25)	-0.27(0.26)
Total publications	0.003***(0.001)	0.003***(0.001)	0.003***(0.001)	0.002***(0.18)
Dumaso	0.29*(0.18)	0.25(0.18)	0. 28(0.18)	0.24(0.18)
Startup age	-0.12***(0.02)	-0.12***(0.02)	-0.12***(0.02)	-0.13***(0.02)
Region dummies	YES	YES	YES	YES
Constant	-1.91***(0.44)	-1.97***(0.44)	-2.29***(0.44)	-2.56***(0.46)
Observations	2000	2000	2000	2000
Num. of groups	191	191	191	191
Log Likelihood	-482.69	-476.19	-461.84	-455.35
Prob > chi2	0.00	0.00	0.00	0.00
Lagrange Multiplier test p value	0.49	0.7	0.96	0.74

Note: *, ** and *** denote significant at 10%, 5% and 1% respectively. Standard errors are in parentheses.

Second, the above results provide strong support that *news*, *coefficient of favorableness*, and *management team heterogeneities* have significant and positive effects on the likelihood of receiving VC funding. What about the effect of these variables on the duration needed to receive the first round VC financing for startups? As a robustness check, we also consider this issue. A classic way to deal with duration data is a hazard model. Since some startups have not received any VC by the end of 2010, the data is right-censored. In this situation, to know the effect of reputation along with management team heterogeneity on the probability of receiving VC funding, the Cox's proportional hazard model is a way which is a semi-parametric model. Moreover, the parametric models impose as much structures as they do the models. Therefore, compared to the parametric models, few restrictions related with the Cox proportional model can lead to a more accurate representation (Hellmann & Puri, 2000). We thus decide to use the Cox proportional model in our case as other scholars investigating VC funding, such as Hellmann & Puri (2000), Haussler et al., (2008), etc. Table 8 presents the results for the duration issue using the Cox's proportional hazard model when we refer management team heterogeneity to team occupational background heterogeneity. It is necessary to note that in our case the shorter the time startups waited for receiving VC funding, the better the outcome. That is, positive coefficients mean startups receive VC funding faster, and negative coefficients indicate slower. All the coefficients on the three independent variables are significant and positive, indicating that they have positive effects on shortening the duration needed to receive the first round VC funding. Therefore, reputation and management team heterogeneity not only have positive effects on the likelihood of receiving VC funds, but also shorten the duration needed to receive the first round VC funds for startups. Table 9 presents the results when we consider team age heterogeneity instead of team occupational background heterogeneity. Generalized visibility (measured by *news*) and generalized favorability (measured by the *coefficient of favorableness*) shorten the duration needed to receive the first

round VC funding. However, the effect of age heterogeneity is not so significant in this case.

Table 8 Cox hazard model on the duration needed to receive VC funding with cluster adjusted standard deviation based on startups (occupational background heterogeneity case)

	Model 1	Model 2	Model 3	Model 4
Number of articles		0.16*** (0.02)	0.12*** (0.02)	0.11*** (0.02)
Coefficient of favorableness			1.63*** (0.33)	1.74*** (0.33)
Background heterogeneity				2.27** (0.96)
Dummy patent	0.77** (0.39)	0.76** (0.39)	0.59 (0.39)	0.66* (0.39)
Average citations	-0.06 (0.36)	-0.03 (0.34)	-0.11 (0.36)	-0.28 (0.39)
Meandoctor	-0.85 (0.63)	-0.68 (0.65)	-0.6 (0.66)	-0.95 (0.78)
Total publications	0.006* (0.003)	0.003 (0.003)	0.004 (0.003)	0.005 (0.003)
Dumaso	1.04** (0.46)	0.95** (0.47)	0.89* (0.52)	0.82* (0.49)
Region dummies	YES	YES	YES	YES
Observations	1416	1416	1416	1416
Log Likelihood	-353.07	-341.96	-330.61	-352.81
Prob > chi2	0.00	0.00	0.00	0.00

Note: Coefficients not hazard rations are shown. *, ** and *** denote significant at 10%, 5% and 1% respectively. Standard errors are in parentheses.

Table 9 Cox hazard model on the duration needed to receive VC funding with cluster adjusted standard deviation based on startups (age heterogeneity case)

	Model 1	Model 2	Model 3	Model 4
Number of articles		0.15*** (0.02)	0.12*** (0.02)	0.11*** (0.02)
Coefficient of favorableness			1.65*** (0.31)	1.61*** (0.32)
Age heterogeneity			0.62 (0.39)	0.85 (0.95)
Dummy patent	0.81** (0.39)	0.79** (0.39)	-0.11 (0.37)	0.56 (0.41)
Average citations	-0.03 (0.37)	-0.02 (0.36)	-0.65 (0.68)	-0.12 (0.38)
Meandoctor	-0.94 (0.66)	-0.76 (0.67)	0.004 (0.003)	-0.73 (0.72)
Total publications	0.006* (0.003)	0.003 (0.003)	0.93* (0.54)	0.003 (0.003)
Dumaso	1.11** (0.49)	0.99** (0.49)	0.4 (1.05)	0.91* (0.54)
Region dummies	YES	YES	YES	YES
Observations	1351	1351	1351	1351
Log Likelihood	-343.63	-332.82	-321.37	-320.67
Prob > chi2	0.00	0.00	0.00	0.00

Note: Coefficients not hazard rations are shown. *, ** and *** denote significant at 10%, 5% and 1% respectively. Standard errors are in parentheses.

Our overall empirical results suggest that the two dimensions of reputation (generalized visibility and generalized favorability) have positive influence on the likelihood of receiving VC funding for startups, providing supports on H1 and H2. Management team heterogeneity, especially management team occupational background heterogeneity which is more directly related with team capabilities, is also positively associated with the likelihood of receiving VC funding. H3 is supported.

4.6 Conclusions

In this chapter, we investigate the effect of different dimensions of reputation on the likelihood of receiving VC funding. Our results provide supports that generalized visibility and generalized favorability dimensions of reputation positively affect the likelihood of receive VC funding. Further, compared to generalized visibility, generalized favorability is more emphasized by venture capitalists. That is, except for generalized familiarity, venture capitalists do value the direction of media coverage. Therefore, we contribute to the literature by providing empirical support on the importance of reputation in VC funding. Practically, to attract VC funding, startups should devote certain time and energy in building reputation. If consider from the perspective of venture capitalists, expect for those signals have been studied in the literature, they should also consider the reputation of startups, especially the favorable reputation of startups, since there are many merits related with favorable reputation, such as building strategic barrier to competitors and attracting other critical resources

About management team heterogeneity, as predicted, there is a positive relationship between occupational background heterogeneity and the likelihood of receiving VC funding. Occupational background reflects professional orientation. A team with diversified occupational backgrounds is more likely to possess different professional expertises leading to diversified capabilities which is important on team capabilities and firm performance. Therefore, venture capitasts perfer a management team with diversified professional backgrounds. Startups should consider this issue when recruiting new directors.

To have a better understanding on team heterogeneity, we also analyze the effect of team age heterogeneity on VC funding. Our empirical results show that there is a significant relationship between them. Due to the limit of data, we only compare the differenct effects of

age heterogeneity and occupational background heterogeneity on VC funding, future work could make a further comparion of other aspects of team heterogeneity on VC funding, such as directors' birth place which may affect the way of thinking, sexual diversity, and so on.

Since we only focus on one sector, the micro and nanotechnology sector, generalizations of our results to other sectors should be careful. Future work could gather data on different sectors and test the effect of different dimensions on the access to VC funding.

We test the influence of reputation on VC funding in this chapter. Because of the "coach" role of venture capitalists, VC funding could also be a signal influencing reputation. This is another direction for future work.

5 Does VC funding increase trademarking in startups?

This chapter is the second empirical study, investigating the effect of VC funding on startups' trademarking activities. It is organized as follows: first there is the introduction section introducing why trademarking can be used as a proxy for innovation and the research question of this study "what is the impact of VC funding on the startup's propensity to file trademarks? Does VC funding lead to the registration of broader trademarks?" Then literature review about registered trademarks and innovation, and the determinants of trademarking activity is discussed in section 2. Section 3 proposes hypotheses. Section 4 presents research context. Section 5 discusses sample and variables and results are discussed in Section 6. Finally section 7 gives conclusions and directions for future research.

5.1 Introduction

The quest to convert inventions (promising novel technical ideas) into successful innovations (commercialized products) is a central challenge for technology-based start-ups. As highlighted by Chandy et al (2006), "firms, whether they work out of tiny garages or in sprawling research

labs, sink much hard-earned capital to generate inventions and bring them speedily to market". Turning promising ideas or patented inventions into successful products, however, is a long-term process involving high risks of failure. As to this point, several contributions in the entrepreneurship literature have shown that venture capital firms, operating as professional and active investors, tend to substantially support their investee companies in enhancing their innovation outcomes. Scholars that have analyzed the relationship between VC investments and innovation have frequently resorted to patent data in order to proxy theinnovative performance of new ventures, generally finding a positive impact of VC funding on patenting levels (Kortum & Lerner, 1998). This approach, however, presents some limitations. On the one hand, there are well-known limits in the use of patents as a proxy of innovation outcomes (Griliches, 1990). Given that innovation is a complex process leading from invention to commercialization (Baregheh et al., 2009), patent counts (and R&D expenditures) are fairly effective proxies only for characterizing the upstream side of firms' innovative processes – i.e. the creation of inventions. However, they poorly represent the downstream side – i.e. the commercialization of innovations -, since many patented inventions tend to never be converted into innovations and commercialized products (Gambardella al., 2007; Munari and Sobrero, 2011).

A recent and rapidly expanding stream of the literature has focused on trademark registrations in order to provide a different and complementary perspective on firms' innovation activities. As trademarks reflect the introduction of new products or services into the market, they are suited to characterize the ability of firms to bring promising ideas to market (Jensen & Webster, 2011; Mendonça et al., 2004). As to this point, several empirical contributions (Gallè and Legros, 2012; Jensen and Webster, 2004; Mendonça et al., 2004; Schmoch, 2003) have convincingly established a tight association between trademarking activity and innovation, even in sectors characterized by a low propensity to patent (i.e. service

sectors). However, studies on firms' trademarking activities have mostly focused on large and established companies, whereas the analysis of new ventures is almost entirely absent in the literature (a notable exception is represented by the recent section by Helmers and Rogers, 2012). Also, there has been no attempt to theoretically and empirically assess the impact of VC funding on trademarking activity of new ventures.

In this chapter we try to complete the picture by analyzing the effect of VC funding on the trademarking activities, exploiting an original dataset of startups operating in the micro and nanotechnology sector in the United Kingdom. We address the following novel research questions: what is the impact of VC funding on the startups' propensity to file trademarks? Does VC funding lead to the registration of broader trademarks?

Empirically, we exploit a hand-collected panel dataset related to 192 new ventures from the micro and nanotechnology sector in the United Kingdom to compare the trademarking activity of VC-backed startups vis-à-vis a control group of other (non VC-backed) new ventures. More precisely, we assess the trademarking activity of VC-backed companies before and after the first round of VC financing (also with respect to the control group) along three different dimensions: the likelihood (or not) to trademark; the number of registered trademarks; the average breadth of registered trademarks (as measured by the number of different NICE classes). Our results highlight that VC funding does have a positive influence on startups' trademarking activities, including the propensity to register trademarks and the number and the breadth of trademarks registered.

The rest of the section is organized as follows. Section 2 provides a review of the relevant literature, whereas Section 3 discusses our hypotheses. Section 4 presents the research context, and the data and the variables are in section 5. Section 6 presents and discusses the findings of our analyses and section 7 presents the conclusions and directions for future research.

5.2 Literature Review

5.2.1. Registered Trademarks and Innovation

A trademark is, in principle, a sign. The function of trademarks is to distinguish products or services of one firm from those of others, in order to prevent consumers' confusion. The economic rationale underlying the protection of trademarks has its roots in economic theories of information and reputation (Landes and Posner, 1987; Menell and Scotchmer, 2007; Ramello, 2006). Trademarks make it possible for consumers to distinguish the products of one company from those of competitors, thus reducing search costs and potential adverse selection. Due to this differentiation role guaranteed by trademarks, firms are encouraged to provide products or services of a consistent and reliable quality, or even improve the quality of their products or services, in order not to depreciate the value of the trademark in the future (Ramello, 2006). Trademarks grant the exclusive right to use a sign and thus provide the firm with a temporary monopoly. Thanks to this role, trademarks can be used as an entry barrier (Greenhalgh & Rogers, 2005) and could enhance a firm's ability to generate financial returns from new products or services (Mendonça et al., 2004; Ramello, 2006; Rujas, 1999; Sandner & Block, 2011).

Trademarks are generally associated with the development and commercialization of new inventions (Schmoch & Gauch, 2009) and could be seen as an element in the process of innovation (Davis, 2006; Greenhalgh & Rogers, 2005). When a firm intends to attract new customers and change its position in the market thanks to the introduction of new products or services, trademarks are a good way to both advertise and protect the new position (Millot, 2009). A strong, consistent finding in the literature, indeed, reveals that the propensity to use

trademarks and registered designs significantly depends on the intensity and type of innovation activities performed by the company (Schmoch, 2003; Mendonca et al., 2004; Millot, 2009). A strong correlation between trademark usage and innovation intensity is well established in a series of academic studies. For example, the CIS 3 survey data quoted by Mendonca et al. (2004) for the different EU countries indicate that innovative firms use trademarks and registered designs more than less innovative firms. Schmoch (2003) uses survey data for German firms referring to the year 2001 and finds a significant correlation between trademarks and innovation (measured as share of turnover generated with new products and new services) in both manufacturing and service industries. In a similar vein, a study of Australian companies by Jensen and Webster (2004) finds that trademarking activity is linked to measures of innovation and product design. Gallè and Legros (2012), analysing a sample of 5295 French companies during the period 2001-2004 based on CIS4 data, note that the probability of using trademarks and registered designs (as well as patents) increases with product innovation activity.

Comparing trademarks with patents, both of them give the owner a temporary monopoly on the protected entity (Mendonça et al., 2004; Rujas, 1999), but while patents are more related to the technological aspects of innovation, trademarks are mostly associated with the commercial aspects of it (Rujas, 1999). Moreover, trademarks - and the brands they protect - foster consumer loyalty (Ramello and Silva, 2006). Accordingly, if patented products have been trademarked before the patent's expiration, trademarks can provide some form of protection even after a patent has expired because trademarks can be renewed indefinitely by paying renewal fees (Rujas, 1999). In this sense, with respect to other knowledge assets which are prone to erode with time, trademarks become increasingly valuable as time passes (Sandner & Block, 2011). Finally, trademarks can be registered for both service sectors and manufacturing sectors whereas patents are mostly used to protect actual products (Greenhalgh, Longland, & Bosworth, 2001).

5.2.2 The Determinants of Trademarking Activity

Empirical literature on firms' trademarking behavior is still limited and in an early stage of development, with only a few studies analyzing the determinants of the use of registered trademarks (Amara et al., 2008; Gallè and Legros, 2012; Mendonça et al., 2004; Schmoch, 2004), and a more sizeable number of studies looking at the impact of trademarking on economic performance (Helmers and Rogers, 2011; Krasnikov et al., 2007), market value (Greenhalgh and Rogers, 2006; Sandner and Bloch, 2011) or employment levels (Greenhalgh and Rogers, 2012). Looking at the former set of studies, their findings suggest that the firm's propensity to use registered trademarks depends on a series of factors, in large part related to the characteristics of the industry and of the firm. As is the case for patents, significant variation appears across industries in their propensity to use trademarks. In a study of UK manufacturing and service firms, Greehalgh et al. (2001) show that the distribution of trademark applications propensities varies substantially across sectors: the percentage of firms with trademarks is highest in the retail sector, whereas it is lowest in the real estate. Moreover, the propensity to register a community trademark is lower than the likelihood to register a UK trademark in all sectors (Greenhalgh & Rogers, 2007). In a similar vein, the results of a 2003 survey among Portuguese companies, as reported by Mendonca et al. (2004), show that significant differences in trademark activity emerge across manufacturing sectors according to their level of technological intensity. According to this study, companies in "higher-tech" sectors (by OECD classification) tend to care about and actually use trademarks more in the course of their business activity than firms in "lower-tech" sectors. In contrast with patents though, trademarks seem diffused also in sectors where patenting activity is particularly limited, such as in low-tech industries or service sectors.

Looking at firm-level determinants, consistent with the findings from patent literature, studies regarding the use of trademarks report a significant role of firm size. A larger firm is generally associated with a higher propensity of registering trademarks (Amara et al., 2008; Bordoy et al., 2007). Amara et al. (2008) conduct a survey of 2625 service firms in Canada to assess the mix of IP mechanisms – patents, trademarks and registered designs – they used. Their regression analyses reveal that firm size is positively and significantly associated with the use of all three protection methods. Firm size is also positively associated with the registration of trademarks in studies by Galliéand Legros in France (2012) and Munari and Santoni in Italy (2011)[2]. Other important factors associated to trademarking activity according to the literature deal with the level of market share (Galliè and Legros, 2012), the affiliation with a business group (Galliè and Legros, 2012; Hanel, 2006) and the degree of internationalization of the company (Munari and Santoni, 2011; Thoma and Birker, 2012).

In the light of such results, therefore, small enterprises, and new ventures in particular, should face significant constraints in their ability to register trademarks. There are different reasons to explain such evidence. A first explanation deals with the costs related to the drafting, deposit and renewal of trademarks, which can represent a significant financial burden for new enterprises. Trademarking has both direct and indirect costs to startups, including direct monetary fees to file trademarks, opportunity costs of time devoted to the filing process, and

[2]A partial exception with regard to trademarks appears in work of Jensen and Webster (2004), who compare the intensity of IP usage (ratio of IP applications to the number of employees) between large firms and SMEs in a large sample of Australian firms over 1994–2001. Their regression analyses, controlling for technology, production and supply characteristics, show no significant differences in the rates of patenting and trademarks by firm size.

other administrative costs, such as the costs to understand trademarking rules and filing procedures, to file a trademark application for each class of goods or services, to file a statement of use and to demonstrate its commercial use. Then at regular intervals, the applicant needs to show that the trademark has been used in commerce for five consecutive years and pay extension fees (Giarratana & Torrisi, 2010). Moreover, trademarks (and other registered IPRs) are costly to monitor and enforce – both in terms of direct legal costs and in terms of indirect business costs of litigation. Since new ventures may not possess enough financial resources to engage in legal disputes and face the related risks, they could prefer to recur to informal protection mechanisms.

To an extent that trademarking- related costs are sizeable for startups, VC funding could allow them to meet these costs. However, despite such observations, there has been a very limited attention in the literature to the trademarking behavior of new ventures, and the role played in this respect by VC investors. As to the first point, an exception is represented by the study of Helmer and Rogers (2010) analyzing the effects of patents and trademarks on the performance and survival probabilities of a sample of nearly 162,000 British new ventures founded in 2001. By focusing on four types of IPRs (UK patent filings, EPO patent filings, UK trademark filings, and Community trademark filings) to capture innovation activity, they show that UK trademarks are the IPR mechanism most commonly used by such startups, followed by community trademarks and then UK patents. When analyzing the relationship between innovation and the survival rates of new firms, the authors find that patenting lowers the probability of exist in only some sectors, whereas trademarking lowers the probability in almost all sectors (Helmers & Rogers, 2010). The only section, to our knowledge, addressing the relationship between VC funding and trademarking activity is a recent working section by Block et al. (2012). Using a sample of US VC transactions from 1998 to 2007, the authors find that the presence and number of trademarks in a start-up relates positively to the start-up's

financial valuation by VCs. Therefore, VCs value trademarks as a signal of the start-up's ability to innovate and market orientation. This study, however, does not analyze changes in trademarking behavior before and after the VC transaction. Moreover, since it focuses only on a sample of VC-backed start-ups, it does not allow to compare the trademarking behavior of VC-backed companies and other start-ups.

5.3 Hypotheses

As we mentioned before, trademark registrations involve both direct and indirect costs to startups. As a first, simple, explanation, it can be argued that the receipt of VC funding makes startups capable of incurring these costs, thus facilitating the recourse to IP protection mechanisms. In addition to that, in addition to financial support, venture capitalists also act as monitor and coacher for their investees (Gompers & Lerner, 2001a). Venture capitalists indeed provide valuable suggestions on strategic planning and marketing management to portfolio startups, and startups are quite short of these capabilities internally. This is typically critical for technology based startups, since most founders of these startups have technological backgrounds and their competences are mainly related with technological inventions, rather that the commercialization of innovations. In addition to that, venture capitalists usually rely on staged capital infusion mechanisms to alleviate the information asymmetry problem and reduce the investment risks (Gompers & Lerner, 2001a; Gompers, 1995). To receive subsequent funds, trademarks, which reflect the potential economic worth of innovations are an important factor influencing the decision of venture capitalists. Therefore, to receive subsequent rounds of funding, startups are expected to be active in trademarking activity.

In short, considering the many functions provided by trademarks, the coaching functions

performed by venture capitalists, coupled with the possibility that financial success could affect a firm's innovation activity (Heimonen, 2012), it is reasonable to believe that upon receiving VC funding, startups will be more likely to file trademarks.

***H1**: Ceteris paribus, in the case of new ventures, receiving VC funding is positively associated with the likelihood of filing trademarks.*

In addition to provide strategic support and marketing management advice, which may influence startups' decision to trademark, venture capitalists may also boost startups' inventions. First, venture capitalists are known for their capability to pick up future successful startups and VC-backed startups are often those which generate innovations that could penetrate huge markets (Cao & Hsu, 2011). Second, venture capitalists' monitoring and coaching role stimulates startups' incentives towards invention. Moreover, once providing investment, venture capitalists have a direct interest to help investees and drive them toward economic success. Their commitment and involvement, for instance the involvement in recruiting scientific personnel, favor startups' inventions (Arqué-Castells, 2012). New inventions with high potential economic returns are often protected with new trademarks, rather than existing ones (Schmoch & Gauch, 2009). Therefore, more inventions spurred by VC financing may lead to more trademark filing. Except for more inventions, VC financing also facilitate product upgrade. New products are always related with new trademarks.

Moreover, the involvement of VC Funding may improve investees' product competitiveness and market share leading to the investees entering into international market. Consequently, to protect their market share, the possibility to file trademarks in the corresponding countries increases. Therefore, VC funding is related with more trademarking filing.

H2: *Ceteris paribus, in the case of new ventures, receiving VC funding positively impacts the number of trademark registrations.*

Another important dimension which is likely to be affected by VC funding in the case of new ventures is the breadth of trademark registrations. This indicates the market scope of a registered trademark, by specifying the set of market segments in which the legal protection of a trademark can be used. Trademarks with a broader scope tend to protect different kinds of products or wider product lines (Sandner & Block, 2011). Given that VC firms are particularly interested in high-growth companies, it is likely that they place more emphasis on the pursuit of diversification strategies by investee companies. Moreover, diversification strategy, especially those diversifying mainly into those areas that share some common core resources, is related with higher levels of profitability (Rumelt, 1982). This could result in more diversified inventions compared to non-venture backed startups. Even though product diversification is a risky strategy for resource constrained startups, since many products share the same critical resources and diversification could bring superior performance, it is expected that VC-backed startups will be more likely to file trademarks with wider breadth. Also, thanks to a diversified product portfolio, startups' resources are bundled and it becomes more difficult for competitors to imitate their products (Wan, Hoskisson, Short, & Yiu, 2011). For such reasons, we expect the following:

H3: *Ceteris paribus, in the case of new ventures, receiving VC funding positively impacts the breadth of registered trademarks.*

5.4 Research context: the MNT sector in the United Kingdom

We test our hypotheses in the context of the micro and nanotechnology sector in the United Kingdom. We adopt a definition of nanotechnology as "the design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/superior characteristic or property" (Bawa et al, 2005). The MNT sector in the United Kingdom is a very interesting and appropriate setting to study the relationship between VC and trademarking activity for several reasons. First, the UK market is second only to the US in the world for what concerns the development of the venture capital industry (Lockett, Murray, & Wright, 2002). Moreover, the MNT sector in the United Kingdom has been characterized by a significant growth over the last two decades, largely driven by the emergence of innovative start-ups and the infusion of risk capital by VC funds (Libaers et al., 2006). Finally, this setting has been already studied by other academic works, which thus represent an useful benchmark for our research (Munari & Toschi, 2011).

5.5 Sample and variables

5.5.1. Sample

To test our hypotheses we use an original, hand-collected dataset of UK startup firms from the MNT sector founded from the year 1996. We constructed the dataset through the following six steps. First, we identified the population of startups operating in the MNT sector founded from

1996 according to the "Industrial Map of UK MNT", an exhaustive map compiled in 2004 by the MNT Network in association with the UK Department of Trade and Industry (DTI). From this source, it was possible to identify 193 new ventures founded from 1996 and onwards. Detailed information about these companies in the report includes the year of foundation, the registered address and a brief company description. Second, we use Companies House (the register including information on all limited companies in England, Wales, Northern Ireland and Scotland) to check for name changes and status for all the startups included in this first sample. Since company name may be altered with time and both VC funding information and trademark information should be retrieved according to company name, we obtained information on all the names in history used by each startup. Third, Thomson One (formerly, VentureXpert) was used to collect VC funding information for all the startups. In this way, we were able to ascertain whether a startup received VC funding or not, and the date of first round of VC financing. Through Thomson One, we were able to identify additional 9 startups operating in the nanotechnology sector.

Fourth, UK trademark and community trademark data was then collected respectively from the online databases of the UK Intellectual Property Office and of the OHIM (Office for the Harmonization of Internal Markets). There are two dates associated with each trademark: the filing date and the registration date. Since trademark filing has already reflected directors' sense of commercializing inventions and protecting their brand, we use filing date as the relevant date in our analyses.

Information on the directors of each startup was then gathered from FAME, the database managed by Bureau and Van D containing comprehensive economic and legal information on companies in the UK and Ireland. For 10 startups we were not able to find related information in FAME, and we exclude them consequently from the sample. Therefore, our final sample includes 192 startups. Detailed director information from FAME include current and previous

list of directors with title, appointment date, resignation date and birthday for each director. Based on the appointment date and resignation date, we manually computed the tenure of each director with the company. We also used the database Company Director Check in order to collect information on each director's previous work experience as directors in other different firms.

In short, we were able to construct an unbalanced panel dataset on 192 startups established from 1996, including 67 VC-funded (around 35% of our sample) and 125 non VC-funded startups. 70 startups (36% of our sample) filed at least one trademark during the observation period.

5.5.2. Variables

Trademarking activity of startups is measured by three variables: the likelihood to file trademarks ($mark_{it}$), the number of filed trademarks ($nmark_{it}$), and the breadth of filed trademarks ($bmark_{it}$). $Mark_{it}$ is a dummy which takes the value 1 if company *i* filed at least one trademark in a year *t*, and zero otherwise. $Nmark_{it}$ measures the number of trademarks filed by company *i* in year *t*. The breadth of trademarks $bmark_{it}$ is measured by the total number of different NICE classes on all the trademarks filed by the focal startup in year *t*.

Our independent variable related to VC funding- $dumvct_{it}$–is a dummy taking value 1 for VC-backed startups from the year of first round of VC funding onwards, and zero otherwise.

We also include in our regression analyses several control variables that may be expected to influence trademarking activity. The age of a company influences its propensity to innovate and ultimate innovation results (Arqué-Castells, 2012). Therefore, we included a variable Age_{it}

in order to measure the age of the company (since its founding year) in each year *t*. Concerning the characteristics of a startup's directors, prior experience as directors in other firms is likely to positively influence their ability to strengthen the competences of the startups, including the innovation and marketing competences. The same can be said by the educational levels of the directors, which may have a positive impact on the startup's innovative results. Therefore, $dumexperience_{it}$ is a dummy variable taking value 1 if any director of the focal startup in a given year has had prior directorship experience in other firms. Another dummy variable $dumPhD_{it}$ takes value 1 if any director of the focal startup in a given year has a PhD title.

Moreover, old directors and young directors have different experiences shaping their different attitudes and values. Diversity of attitudes and values facilitate creativity (Bantel & Jackson, 1989). We expect the more diversified are the ages of the company directors, the more ability a startup has for dealing with innovation and trademarking activity. We thus computed a variable $ageheterogeneity_{it}$ by dividing directors into 5 groups with respect to their ages: directors with ages between 20 and 30; ages between 31 and 40; ages between 41 and 50; ages between 51 and 60; and ages older than 60[3]. Then age heterogeneity is calculated with the following formula (Bantel & Jackson, 1989):

$$\text{ageheterogeneity} = 1 - \Sigma p_i^2$$

where p is the proportion of team members in each of the five age categories, with *i* signaling each category.

To control for influential factors related to the business and technological cycle, we include a set of 16 year dummies. As shown by Table 10, more than 80% startups received their first round VC and filed their first trademark during the same period, that is, between the year 2000 and 2007. This fact tells us that this period may be a flourish period of business cycle and

[3]In our sample, the youngest director is 21 years old.

technological cycle.

Table 10 Distribution of the Years in which Startups Received their First Round of VC-Financing and their First Trademark

	Receiving First VC			Filing First Trademark		
Year	**Frequency**	**Percentage**	**Cumulative**	**Frequency**	**Percentage**	**Cumulative**
1996				1	1.43	1.43
1997	2	2.99	2.99	0	0	1.43
1998	2	2.99	5.98	1	1.43	2.86
1999	2	2.99	8.97	2	2.86	5.72
2000	14	20.9	29.87	6	8.57	14.29
2001	7	10.45	40.32	12	17.14	31.43
2002	6	8.96	49.28	6	8.57	40
2003	7	10.45	59.73	7	10	50
2004	6	8.96	68.69	9	12.86	62.86
2005	8	11.94	80.63	5	7.14	70
2006	2	2.99	83.62	9	12.86	82.86
2007	5	7.46	91.08	7	10	92.86
2008	2	2.99	94.07	2	2.86	95.72
2009	1	1.49	95.56	0	0	95.72
2010	2	2.99	98.55	2	2.86	98.58
2011	1	1.49	100	1	1.43	100
Total	67	100		70	100	

Innovation is sensitive to the geographic location of each company, due to spillover effects and to the positive influence of local networks in facilitating resource acquisition (Almeida & Kogut, 1997). Therefore, a set of 12 region dummies are included.

All the variables used here and the sources used to search the information are summarized in Table 11.

Table 11 Summary of Variables and data Sources

Variable	Description	Source
Dependent Variables		
Markit	Dummy taking the value of 1 if the focal startup filed at least one trademark at year t	OHIM and UK IPO
$Nmark_{it}$	The total number of filed trademarks by the focal startup at year t	OHIM and UK IPO
$Bmark_{it}$	The breadth of filed trademarks by the focal startup at year t	OHIM and UK IPO
Independent Variables		
Dumvct	Dummy with value 1 for VC-funded startups from the year of VC entry onwards	Thomson One
Control Variables		
Dumexperience	Dummy with value 1 if any company director has previous directorship experience in other firms	FAME; Company Director Check
DumPhD	Dummy with value 1 if any director is a doctor	FAME; Company Director Check
Ageheterogeneity	Management team age heterogeneity in a given year for a startup	FAME
Year dummies	A set of 16 year dummies	MNT
Region dummies	A set of 12 region dummies	MNT
Age	Startup's age	MNT

5.6 Results

5.6.1 Descriptive Analysis

Table 12 presents descriptive statistics for all the variables used in this section. The mean likelihood of trademarking for a startup in a given year is 0.068. The mean number of filed trademarks per year for the sample companies is 0.136, whereas the mean breadth of trademarks is 0.205. The mean value of dumexperience is 0.865, indicating most startups have at least one director with prior directorship experience. Similarly, around half of the startups have at least one director with PhD title. This result is consistent with the fact that as a high technology, the application of micro and nanotechnology is still not perfectly understood and the use of it is associated with some tacit knowledge, requiring to include experts in the management team. Startups studied in this chapter have the average age of 5 years old.

Table 12 Descriptive Statistics (Main Variables)

Variable	Obs.	Mean	Std. Dev.	Min	Max
Markit	2074	0.068	0.252	0	1
Nmark	2074	0.136	0.651	0	15
Bmark	2074	0.205	1.024	0	19
Dumvct	2074	0.274	0.446	0	1
Dumexperience	1868	0.865	0.341	0	1
DumPhD	1963	0.678	0.467	0	1
Ageheterogeneity	1895	0.432	0.261	0	1
Age	2074	5.261	3.633	0	15

Table 13 shows that, generally, 67 startups received VC funding and 70 startups filed trademarks. It suggests that VC-backed startups tend to receive the first round of financing and file their first trademark when they are very young. Moreover, it suggests that VC-backed startups are more likely to receive the first round VC first and then file their first trademark (for instance, at the founding year, 22% startups received their first round VC but only 15% filed their first trademark).

Table13 Distribution of Startup Age when Receiving First VC Funding and Filing First Trademark

	Received First VC Funding			**Filed First Trademark**		
Age	**Frequency**	**Percentage**	**Cumulative**	**Frequency**	**Percentage**	**Cumulative**
0	15	22.39	22.39	11	15.71	15.71
1	16	23.88	46.27	11	15.17	31.42
2	8	11.94	58.21	15	21.43	52.85
3	9	13.43	71.64	4	5.71	58.56
4	3	4.48	76.12	9	12.86	71.42
5	8	11.94	88.06	6	8.57	79.99
6	4	5.97	94.03	4	5.71	85.7
7	2	2.99	97.02	1	1.43	87.13
8	0	0	97.02	1	1.43	88.56
9	1	1.49	98.51	5	7.14	95.7
10	1	1.49	100	1	1.43	97.1
11				1	1.43	98.56
14				1	1.43	100
Total	67	100		70	100	

Table 14 shows that 51% of venture-backed startups filed at least one trademark; whereas only 29% of non VC-backed funded ones filed for trademarks. The chi-squared test confirms that the difference in the frequency levels between the two groups is statistically significant at 1% level.

Table 14 Likelihood of Trademarking: VC-Funded vs. Non VC-Funded Startups

Variable	Group	VC-Funded Startups		Non VC-Funded Startups	
		Frequency	**Percentage**	**Frequency**	**Percentage**
Dummy trademark	Yes	34	50.75	36	28.8
	No	33	49.25	89	71.2
	Total	67	100	125	100
	Pearson Chi-square	9.0688			
	P value	0.003			

Moreover, for the sample of VC-backed companies, it can be seen from Table 15 that the propensity to trademark is higher after the first round of VC financing rather than before. In more detail, 29 VC-backed startups (43% of them) show trademark filing activity after first VC funding, as compared to only 12 of them (18%) before VC entry. Even more striking, the average number of trademarks filed per company after VC entry is more than twice the number of trademarks before VC entry (4.38 trademarks after vs. 2.08 trademarks before).

Table 15 Venture Capital Funding, Number of Trademarks and Timing of Trademarking Activity

	VC Funded Startups			Non VC Funded Startups		
	Total Number of Trademarks	Number of Startups Trademarking	Average Number of Trademarks per Startup	Total Number of Trademarks	Number of Startups Trademarking	Average Number of Trademarks per Startup
Trademark filing:	152	34	4.47	131	36	3.64
…before VC funding	25	12	2.08	-	-	
…after VC funding	127	29	4.38	-	-	

Taken together, Table 14 and Table 15 seem to suggest that compared with non VC-backed startups, VC-backed startups are in general more active in trademarking activity, and that a significant increase in trademarking activity occurs after VC entry. However, firm-specific characteristics which may affect both VC financing and trademarking activity are not considered in these statistics. We therefore undertake more systematic regression analyses in order to investigate in more detail the impact of VC on trademarking.

5.6.2 Regression analyses

Table 16 reports the correlation matrix on all the variables. It does not indicate the presence of multicollinearity issues in our case.

Table 16 Correlation Matrix (Main Variables)

	Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Mark	1							
2	Nmark	0.77*	1						
3	Bmark	0.75*	0.65*	1					
4	Dumvct	0.08*	0.08*	0.05*	1				
5	Dumexperience	0.08*	0.07*	0.06*	0.16*	1			
6	DumPhD	0.06*	0.05*	0.03	0.13*	0.03	1		
7	Ageheterogeneity	0.06*	0.05*	0.02	0.20*	0.36*	0.27*	1	
8	Age	-0.01	-0.01	-0.004	0.18*	0.05*	-0.01	0.07*	1

* correlation is significant at 5% level.

Three dependent variables are used in our analyses: the probability of trademarking in each year, the number of trademark applications per year and the breadth of trademarks per year. We thus estimated different regression models using panel data approaches, given the longitudinal nature of our data. We used a logit model for variable on the probability of trademarking, given its dummy nature. As far as the number of trademark filings and the breadth of trademarks are concerned, we choose the negative binomial model, since we are dealing with count data (we also used a Poisson model as robustness check, as shown in the

next section of the section).

Following the classical process to deal with panel data, we first run a Hausman test to choose between fixed effect and random effect model. The Hausman test results reveal that for all the models, a random effect model is appropriate. Table 17 thus presents our regression results using the random effects specification.

To ensure the robustness of results, when analyzing the effect of *dumvct*on the three dependent variables (Model 1, 2 and 3), we start with a univariate regression which only includes *dumvct* as explanatory variable (Column 1 of Model 1, 2, and 3). Then in Column 2 of each model, we control for team characteristics. We then additionally include the remaining control variables - namely startup age, regional dummies and year dummies - in Column 3 of each model to see how the results change.

Table 17 Main Regression Results

Dependent Variable	(1)			(2)			(3)		
	Mark			Nmark			Bmark		
Model	Logit RE	Logit RE	Logit RE	Negative binomial RE	Negative binomial RE	Negative binomial RE	Negative binomial RE	Negative binomial RE	Negative binomial RE
Dumvct	0.69** (0.28)	0.51* (0.28)	0.54* (0.3)	0.77*** (0.23)	0.66*** (0.23)	0.65*** (0.25)	0.71*** (0.23)	0.62*** (0.23)	0.56** (0.26)
Dumexperience		0.85 (0.56)	0.79 (0.58)		0.95* (0.52)	0.92* (0.53)		1.02** (0.52)	0.88 (0.54)
DumPhD		0.36 (0.29)	0.22 (0.31)		0.37 (0.25)	0.19 (0.25)		0.26 (0.25)	0.07 (0.26)
Ageheterogeneity		1.04* (0.57)	1.15** (0.59)		0.58 (0.47)	0.69 (0.49)		0.26 (0.47)	0.49 (0.49)
Age			0.03 (0.08)			0.02 (0.06)			0.05 (0.06)
Region Dummies	No	No	Yes	No	No	Yes	No	No	Yes
Year Dummies	No	No	Yes	No	No	Yes	No	No	Yes
Constant	-3.43*** (0.22)	-4.87*** (0.59)	-5.42*** (1.17)	-1.92*** (0.22)	-3.33*** (0.56)	-3.56*** (0.7)	-2.62*** (0.2)	-3.87*** (0.54)	-6.28*** (1.35)
Observations	1820	1820	1820	1820	1820	1820	1820	1820	1820
N. startups	178	178	178	178	178	178	178	178	178
Log Likelihood Prob> chi2	-444.22 <0.01	-438.36 <0.01	-420.97 <0.05	-639.63 <0.01	-634.44 <0.01	-615.4 <0.01	-686.83 <0.01	-683.01 <0.01	-653.79 <0.01
Hausman test p value	0.198	0.11	0.85	0.59	0.26	1	0.87	0.6	0.89

*** p<0.01, ** p<0.05, * p<0.1Standard errors in parentheses.

The coefficients of the variable *dumvct* in the different specifications of model (1) are all positive and statistically significant at 10% level, giving support for our first hypothesis H1. The coefficients for *dumvct* in the three columns are also positive in Model 2 related to the number of trademark applications, showing a more pronounced statistical significance (at the 1% level). This indicates a strong positive effect of VC funding on the intensity of trademark applications. Finally, as for the breadth of trademarks, the results in Model 3 indicate a positive and statistically significant effect (at the 5% level) of the variable related to VC funding, thus supporting our third hypothesis. The only significant control variable in model 1 is directors' age heterogeneity. Even though other control variables are not significant, they enter with the predicted sign. Moving to model 2 and 3, year 1996 has a significant and positive influence on the number of trademark applications and the breadth of trademarks. This is maybe because the community trademark application system was first introduced in 1996.

In short, after controlling for a set of potentially influential factors, our findings provide a robust support to our hypotheses and suggest that VC financing is positively related with startups' trademarking activities.

5.6.3 Robustness check

We address first the issue of endogeneity, stemming from the fact that firms that trademarks could differ in unobservable ways from firms that do not trademark (such as in the quality of their underlying products and technologies), which lead then to a higher probability to receive VC funding. To control for the potential endogeneity issue, we use an instrumental variable approach. In order to find a suitable instrument for VC funding, we first recur to a variable

capturing the reputation of a firm, given that this is often positively associated with its economic outcomes which are valued by venture capitalists (Lange et al., 2011). Following previous studies, we construct a measure of reputation based on media coverage of the company in the press (Deephouse, 2000; Pollock and Rindova, 2003). More precisely, we capture reputation using the so-called coefficient of favorableness (Deephouse, 2000):

$$\text{Coefficient of favorableness} = \begin{cases} (\mathrm{f}^2 - \mathrm{fu})/(\mathrm{total})^2 & \text{if } \mathrm{f} > u \\ 0 & \text{if } \mathrm{f} = \mathrm{u} \\ (\mathrm{fu} - \mathrm{u}^2)/(\mathrm{total})^2 & \text{if } \mathrm{u} > f \end{cases}$$

where "f" is the stock of favorable news; "u" is the stock of unfavorable news; "total" is the stock of total news[4].

We first estimated a bivariate probit regression model, reported in Table 18, in order to validate our choice of instruments. The results reported in Table 18 show that reputation seems to positively influence VC funding, but it does not have a statistically significant association with trademarking. It also confirms that VC funding and trademarking are significantly related with each other.

[4]We used Lexis-Nexis in order to gather information on the coverage in the media of the new ventures included in our sample. We identified citations in the news in the UK newspapers. We coded an article as favorable if it praised the startup for its actions or involvement in some events that may increase its reputation, such as receiving award for its technology; we coded an article as unfavorable if it criticized the startup for its actions or involvement in some events that may decrease its reputation, such as massive layoffs; and we coded an article as neutral if there was no evaluations about the startup.

Table 18 Biprobit Regression

	Markit	**Dumvct**
Dumexperience	0.57**	0.52*
	(0.23)	(0.29)
Dumdr	0.07	0.15
	(0.15)	(0.18)
Ageheterogeneity	0.18	0.86**
	(0.35)	(0.35)
Age	-0.02	0.05***
	(0.02)	(0.02)
Coefficient of Favorableness	0.18	0.54***
	(0.14)	(0.22)
Constant	-2.05***	-1.97***
	(0.22)	(0.33)
Observations	1695	1695
Rho	0.19	
	(0.09)	
Prob> chi2	0.04	

*** p<0.01, ** p<0.05, * p<0.1Standard errors in parentheses.

We therefore use startup reputation as an instrumental variable to control for the endogeneity issue. Table 19 presents the results of our estimates based on the instrumental variable approach. They confirm the positive and statistically significant impact of VC funding on the trademarking propensity of startup firms.

Table 19 Instrumental Variable Estimation

Dependent Variable	**Markit**
Dumvct	0.26***(0.09)
Dumexperience	-0.005(0.03)
Dumdr	0.004(0.02)
Ageheterogeneity	-0.003**(0.04)
Age	0.0007(0.005)
Constant	-0.06(0.06)
Region Dummies	YES
Year Dummies	YES
N. observations	1695
N. startups	178
R^2(overall)	0.02
Prob> chi2	0.02

*** p<0.01, ** p<0.05, * p<0.1Standard errors in parentheses.

Secondly, as discussed before, we also used a Poisson regression model as robustness check, to see whether the results related to the count dependent variables remain confirmed. Table 20 reports the results of the Poisson regression estimates, which are largely in line with the results emerging from the previously reported negative binomial model.

Table 20 Poisson Regression Results

Dependent Variable	**Number of Trademarks ^**	**Breadth of Trademarks °**
Dumvct	0.94***(0.24)	0.54**(0.24)
Dumexperience	1.12**(0.55)	0.56(0.47)
Dumdr	0.28(0.23)	0.18(0.19)
Ageheterogeneity	1.05***(0.41)	0.85**(0.36)
Age	0.03(0.07)	0.09(0.09)
Constant	-4.04***(1.06)	-5.9***(1.31)
Region Dummies	YES	YES
Year Dummies	YES	YES
N. observations	1820	1820
N. startups	178	178
Log Likelihood	-693.43	-894.05
Prob> chi2	<0.01	<0.01
Hausman test p value	0.73	0.99

*** p<0.01, ** p<0.05, * p<0.1Standard errors in parentheses. ^ Random effects model. °Random effects model.

As for the effect of VC financing on the number of trademarks, the coefficient of *dumvct* is significant at 1% level. About the effect of VC financing on the breadth of trademarks, the effect of *dumvct* on the breadth of all trademarks remains significant as with the main regression results. Taken together, the results remain virtually unchanged when we use different models.

5.7 Conclusions

Although the effect of VC on innovation has been extensively studied, most researchers depict innovation by patent data. Nevertheless, patent is a good proxy for the upstream side of innovative performance (the creation of inventions), but it is not good at capturing the downstream side of innovative performance (the commercialization of inventions). In contrast, trademark is more related with the commercialization side of innovation. In addition, the number of trademark applications from UK firms has nearly doubled that of patents (Greenhalgh & Rogers, 2012). Trademarking activity is thus can be used to complement our knowledge about the relationship between VC and innovation.

In this chapter we have tried to evaluate the impact of VC on trademarking activities of startups. Our results provide strong evidence on the existence of a positive association between VC financing and startups' trademarking activities. More specifically, the logit model results provide support on the positive effect of VC funding on the likelihood of registering trademarks, and both the negative binomial model and Poisson model support a positive association of VC funding with the number of trademark applications and the breadth of trademarks.

We thus contribute to the vast literature on the importance of venture capital funding for the growth of startups companies, complementing previous results using patent data. Using a complementary perspective on innovation activities by startup companies centred on trademark filings, and by that closer to the introduction into the market of novel products or services, we confirm the value-adding role of venture capitalists as catalysts for innovation related activity.

We also contribute to the emerging literature on trademarking activity, highlighting a novel determinant of the startups' propensity to trademark, namely venture capital funding. This suggests the important role played by funding sources and external investors on the use of

different IPR mechanisms by companies (and new ventures in particular), an issue that deserves further inquiry by future research.

The chapter also has some limitations which can be investigated by future researches. First, while using data from a single sector– micro and nanotechnology – ensures internal validity, caution should be applied in generalizing our results to other sectors, especially those low technology based sectors. Future research could thus extend the study by including also low technology based sectors.

Second, we studied the impact of VC funding on trademarking activities of startup companies. However, we do not know the impact of amount of VC funds startups received on their subsequent trademarking activities. In addition, our results indicate that VC funding does have positive influence on trademarking activities, but we do not know the mechanism through which VC funding increases startup companies' trademarking activities, such as what activities they undertake or what type of support they actually provide in order to facilitate trademarking and innovation.

6 Discussion and conclusions

This chapter first gives a brief conclusion of the dissertation. In section 2 we discuss the limitation of the dissertation and provide some ideas on the future research avenues. Managerial and policy implications are discussed in the last section of this chapter.

6.1 Conclusions

Startups, especially technology based startups, are important in improving industry innovation and competition. However, due to their newness, information about their performance track record is limited. In addition, the market prospect of new technologies is uncertain. All these problems make startups confronting the problem of attracting funds. However, to some extent, venture capitalists can alleviate the problems due to their "scouting" and "coaching" role (Baum & Silverman, 2004). VC funding is one of the most optimal financial intermediaries for technology based startups. There is a wide literature on VC funding. We focus on two streams of VC studies in this dissertation. One is about the criteria used by venture capitalists to assess startups and the other is about the impact of VC on startups' innovation.

In the literature, criteria related with the startup team, the product differentiation, the financial returns, the market attractiveness, and social ties have been considered important factors influencing venture capitalists' investment decisions (Petty & Gruber, 2011; Tyebjee & Bruno, 1984). Even though all these criteria are important, they are all correlated with one dimension of reputation, namely the attribute specific dimension, because they can lead to a

startup's being known for something (Lange et al., 2011). However, knowledge about effect of the other two dimensions of reputation (generalized visibility and generalized favorability) on VC funding is limited. We thus complete the picture by investigating the effect of the other two dimensions of reputation on VC funding. Our empirical results provide support on the positive effect of generalized visibility and generalized favorability on the likelihood of receiving VC funding. In addition, we also investigate the effect of top management team heterogeneity on VC funding. Management team is one of the most important factors considered by venture capitalists (MacMillan et al., 1985; Tyebjee & Bruno, 1984; Muzyka et al., 1996). There are several studies having analyzed the relationship between management team heterogeneity and performance in the literature (Bantel & Jackson, 1989; Laursen et al., 2004; Giuri et al., 2010), whereas knowledge about the role of management team heterogeneity in attracting VC funding is rare. Our empirical results support that management team heterogeneity has a positive impact on the likelihood of receiving VC funding.

Thus, this empirical study has a threefold contribution to the literature. First, we analyze the effect of reputation on VC funding. We find startups' reputation is another important criterion used by venture capitalists. Second, we analyze the effect of team heterogeneity on VC funding. Our empirical results confirm its positive impact on VC funding. Third, we use media coverage to measure two different dimensions of reputation. The number of media coverage is used to measure generalized visibility dimension of reputation and the coefficient of favorableness is used to measure generalized favorability dimension of reputation. In the literature, most scholars use Fortune Magazine's reputation index to measure reputation (Bauer, 2010; Highhouse et al., 2009a; Lange et al., 2011). Nevertheless, this approach has received several criticisms in the literature. For example, it is mostly linked with firms' previous financial performance, rarely about other aspects (Bauer, 2010; Brown & Perry, 1994b; Fryxell & Wang, 1994).

The second empirical study in this dissertation is about the effect of VC funding on startups' innovation. In the literature, innovation has been frequently captured by patent data (Bertoni et al., 2010; Kortum & Lerner, 1998; Kortum & Lerner, 2000). Patent counts are good to capture the creation of inventions. However, they are poorly in capturing the commercialization side of innovations (Millot, 2009). In contrast, trademarks are related with the firms' capability to bring promising ideas to market (Jensen & Webster, 2011; Mendonça et al., 2004). To better understand the effect of VC funding on innovation, we analyze the effect of VC funding on startups' trademarking activities. More specifically, we investigate the effect of VC funding on three aspects of trademarking activities: the likelihood of filing trademarks, the number of trademarks filed, and the breadth of trademarks filed.

Our empirical results confirm the value adding role of VC funding on startups' innovative performance. VC funding positively influence all the three aspects of trademarking activities.

Therefore, this study has at least twofold contributions to the literature. First, we analyze the effect of VC funding on trademarking activities, complementing the picture of the effect of VC funding on innovation in which the researches mainly resort to patent data to depict innovation. Our empirical results support the positive influence of VC funding on startup's trademarking activities. Second, we contribute to the trademarking literature by providing support that VC funding is an important determinant of startups' trademarking activity.

6.2 Managerial implications

The results of this dissertation have practical implications both on startup management and VC funding management.

Managerial implications for the startup management

First, even though most startup entrepreneurs acknowledge that a reputation, especially a favorable reputation, plays an important role in future development, there is a failure to translate this notion into real actions (Goldberg, Cohen, & Fiegenbaum, 2003). In addition, firms differ in their relative success in building reputations (Highhouse et al., 2009). Considering that reputation is important in attracting capital, startup entrepreneurs should value reputation building in their daily management. Startup entrepreneurs could make some policies on reputation building. For example, if possible, they could distribute certain financial resources on special use in reputation building and assign certain employees to be responsible for reputation building activities. Moreover, we find media coverage is important in capturing a startup's reputation. Thus, promoting media visibility and media favorability are two important managerial implications for startup entrepreneurs. Startup entrepreneurs could improve media visibility by devoting certain resources on advertising, building good relationship with the media, and so on.

Second, as we highlight, reputation is a multi-dimensional concept and has many dimensions, such as management capabilities, product quality, working environment, etc. Considering that startups are usually resource limited, startup entrepreneurs could make some strategic plans on the focus of certain specific reputation dimensions at different development stages. Our empirical results suggest that generalized favorability is the most important dimension of reputation influencing VC funding. However, generalized favorability is often accumulated through relative long-term efforts. Given that top management team heterogeneity also has positive contributions on receiving VC funding, in this situation, we suggest that startup entrepreneurs could start reputation building with enhancing top

management team heterogeneity, for example, when recruiting new directors, startup entrepreneurs could choose those who have different occupational backgrounds or in different age cohorts with incumbent ones.

Third, since VC funding positively influence startups' trademarking activities which is often associated with their market performance, startup managers could consider VC funding as one of the optimal capital resources. Moreover, compared with other financial resources, except for capital support, venture capitalists also contribute to startups by providing managerial suggestions which is vital on startup development. Therefore, if to choose between VC funding and other financial resources, the positive effect of VC funding on their future innovation and performance should be one critical aspect considered by startup entrepreneurs.

Managerial implications for VC managers

Except for managerial implications for startup entrepreneurs, managerial instructions can also be drawn for VC managers. First, startup reputation should be another criterion used to evaluate startups and make investment decisions. Especially, in the early stage of evaluation, VC managers could resort to media to collect more information about startups and to solve the information asymmetry problem to some extent.

Second, VC managers should manage their organizations toward building competences which are short in startups. Once making investment, VC firms' future is tightly related with investee companies' future. Startups often lack market strategic capabilities. Different with patenting which is related with the invention stage of innovation, trademarking is more related with the commercialization stage of innovation. Inventions could bring returns only when they are commercialized, even some patents have never been commercialized. Our empirical results indicate that VC funding has positive impact on startups' trademarking activities. In

order to help better startups on trademarking activities, VC managers should build capabilities about bringing inventions into market.

Policy implications

Our dissertation also has some policy implications for the government. New ventures are important in a country's economic growth. VC funding could enhance new ventures' innovation. Therefore, government can make some policies helping startups, especially those operating in nascent high-technology based sectors, to obtain VC funding. In addition, startups' reputation has positive influence on their likelihood of receiving VC funding. The government should also help startups to build favorable reputations. For example, the government could organize some training activities in order to help startup entrepreneurs to have a better understanding on the procedure of applying for VC funding, what criteria venture capitalists use to evaluate potential deals, the evaluation process of venture capitalists, and so on.

Moreover, the government could act as an intermediary among VC managers, startup entrepreneurs and the media in order to facilitate their interactions. For example, they could create a platform to facilitate the communication between VC managers and startup entrepreneurs. Also, the government could organize some events making startups visible to the media or having opportunities to communicate with the media. The government even could organize some events and invite VC managers, startup entrepreneurs, and the media to participate so that they have chances to interact with each other.

6.3 Limitations and directions for future research

Although we provide contributions to the literature, we acknowledge there are some limitations in this dissertation which can be further analyzed in the future.

Limitations related with the empirical setting of the whole dissertation

The first groups of limitations are associated with our empirical setting in this dissertation. First, even though MNT sector is an interesting setting to study our research questions, generalization of our results to other sectors should be careful. MNT is an emerging technology and its practical applications are not so perfectly understood, which is different with other mature technologies in the sense that emerging technologies may represent the future of a market and be more likely to obtain above-normal returns, thus are more likely to attract VC funding. That is, MNT sector may be a factor attracting venture capitalists' attention. As a consequence, the relationship between reputation and VC funding may be affected by the MNT sector. Therefore, future work may collect additional data from other sectors, especially mature technology related sectors, to do some cross-sector comparisons in order to have a more general understanding about the relationship between reputation and VC funding. Similar limitations can be said for the relationship between VC funding and trademarking. Startups operating in the MNT sector are high-technology based startups, which is different from low-technology based startups in that high-technology based startups are more likely to have inventions and thus more likely to have trademarking activities. This suggests that except for the factors we consider in this dissertation, MNT sector itself may be another factor influencing startups' trademarking activities. Thus, future work could rely on data from startups operating in low-technology based sectors to have a deeper knowledge

about the relationship between VC funding and innovation.

The second limitation related with the empirical setting is that we only consider startups in this dissertation. Reputation is important not only for startups, but also for established large firms, considering that favorable reputation is often associated with higher performance and that to some extent, favorable reputation could reduce the possibility of engaging in opportunistic behaviors by investee companies because otherwise unfavorable news may be reported which may reduce their possibility to receive additional funds. Even though startups confront more funding problems compared with established large firms, large firms also have the fund problem. Reputation may be a factor influencing the likelihood of receiving funds for large firms. Future work could also investigate the relationship between reputation and VC funding for large firms, or even could compare the impact of reputation on startups and established large firms on receiving funds to look at whether the role of reputation is different.

The third limitation related with the empirical setting is about the focus of one country, the United Kingdom. Since different countries have different institutional environments, especially concerns institutional environments on VC and trademarking, focusing on one single country ensures internal validity. On the other hand, different institutional environments make our results cannot be simply generated to other countries. For example, the scientific capability of the UK universities and institutions is in a well-known position in the world, which can provide R&D support for high-technology based firms and thus contribute to their innovations.

Limitations related with the empirical study on the effect of reputation on VC Funding

The second group of limitations is related with the first empirical study. First, we investigate the effect of team occupational background heterogeneity and team age heterogeneity on the likelihood of receiving VC funding. However, except for these two aspects

of team heterogeneity, there are several other aspects such as team industry experience, tenure, race, gender, etc. For example, directors having same race or gender are likely to categorize them into one group, which may facilitate affiliation among them but may also provoke intragroup hostility (Jehn et al., 1999). Which side of effects has dominant influence on receving funds? Team occupational background heterogeneity is more directly related with team capability. Age is more related with a person's value and perspectives, which may indirectly influence team creativity (Simons et al., 1999). Race or gender is even less job-related than age. Do job-related dimensions of team heterogeneity have more influences on receiving funds? Future research could analyze other dimensions of team heterogeneity and compare their different effects on receiving funds.

We analyze the effect of reputation on the likelihood of receiving VC funding. However, we have no idea where reputation comes from for startups. Stakeholders could construct reputations for a large established firm from many signals, such as market and accounting signals, institutional signals (for instance, institutional ownership, firm size, etc), strategy signals (for instance, differentiation, diversification, etc) (Fombrun & Shanley, 1990). However, due to limited performance track record and limited resources that can be devoted to building reputation, the antecedents of reputation for startups should be quite different from established large firms. However, each startup has an initial reputation (Mahon & Wartick, 2003). The antecedent of reputation for startups is thus a critical issue for future research. Moreover, knowledge about the antecedents of reputation could help us in understanding how to build reputation and how reputation develops. There are some studies having analyzed how to build reputation. For example, Highhouse et al. (2009b) provide a conceptual framework of the formation of corporate reputation. Goldberg et al. (2003) propose four strategies for reputation building: dynamic exploitation of existing assets, development of core competencies, image management, and strategic alliances, but they investigate the effect of

the strategies on reputation resorting to field research on three software companies in Israel during the years 1997-1998. Nevertheless, the research on startups using quantitative research method is rare. Therefore, more empirical search in this area is called.

Limitations related with the empirical study on the effect of VC on trademarking

The third group of limitations is related with the second empirical study. First, in the second empirical study, even though our empirical results confirm the positive influence of VC funding on trademarking activities, we do not analyze what actions venture capitalists undertake in facilitating startups' trademarking activities. Many actions related with VC funding may stimulate trademarking activities, for instance, supplying enough funds, providing managerial suggestions especially suggestions on product commercialization, adopting tight monitoring, and so on. Which activity has more contributions on trademarking activities? Future research could compare the impacts of different actions venture capitalists adopt and find the actual actions which have more contributions on startups' trademarking activities.

Second, we investigate the influence of VC funding on trademarking for startups in three aspects: the likelihood of having trademarks, the number of trademarks registered, and the breadth of trademarks registered. Sandner & Block (2011) provide four indicators to measure trademark value: Nice classes of a trademark, seniorities claimed, oppositions brought by an applicant, and oppositions received by a trademark application. We just consider one indicator of trademark value in this dissertation, namely, Nice classes of trademarks. Based on the four measures, future research could analyze the effect of VC funding on the quality of trademarks registered along all the four indicators. Normally, the four indicators are positively related with a trademark's value. Moreover, trademark is often positively associated with consumers' purchasing decision, which may improve firms' sells. Trademarks also positively influence

companies' market valuations (Sandner & Block, 2011). We provide support that VC funding is an important factor on new ventures to create trademarks. However, except for VC funding, are there any other factors influence trademarking activities? This is another issue which could be investigated in future.

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